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RESEARCH ARTICLE

SUPPLIER SELECTION PROCESS WITH MULTI CRITERIA DECISION MAKING TECHNIQUES; AN APPLICATION

Çok Kriterli Karar Verme Teknikleri ile Tedarikçi Seçim Süreci; Bir Uygulama

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ABSTRACT

This study aims to investigate, how the selection of airline company information technology department software company is determined by multi criteria decision making techniques. Research population consist of all airline companies in Turkey and the sample consist of leading position in the national airline of Turkey. Data were collected with " Saaty scale" . The scale was mutually evaluated by the decision-making group. In order to ensure the accuracy of the data mixed methods research was used combining both quantitative and qualitative research methods. The results of data analysis, after selecting the airline company information technology department software company, weights of criteria with AHP, TOPSIS and VIKOR methods were used together to select supplier company.

Keywords: Multi criteria desicion making, AHP, TOPSIS, VIKOR, Supplier selection, Airway

ÖZET

Bu çalışma, havayolu şirketi bilgi teknolojileri departmanı yazılım şirketi seçiminin çok kriterli karar verme teknikleri ile nasıl belirlendiğini ortaya çıkarmayı amaçlamaktadır. Araştırmanın evrenini Türkiye'de bulunan tüm havayolu şirketleri oluşturmaktadır. Araştırmanın örneklemeni ise Türkiye'nin önde gelen lider pozisyonunda bulunan milli havayolu şirketi oluşturmaktadır. Araştırmanın verileri "Saaty ölçeği" ile toplanmıştır. Ölçek, karar verici grup tarafından kriterlerin önem derecelerinin karşılıklı olarak değerlendirilmiştir. Araştırmada nitel ve nicel yöntemlerin bir arada kullanıldığı karma araştırma modeli kullanılmıştır. Bu araştırmanın sonucunda havayolu şirketi bilgi teknoloji departmanı yazılım şirketi seçimi AHP ile kriterlerin ağırlıkları belirlendikten sonra, TOPSIS ve VIKOR yöntemi kullanılarak birinci tedarikçi firmanın en iyi seçim olacağı saptanmıştır.

Anahtar Kelimeler: Çok kriterli karar verme, AHP, TOPSIS, VIKOR, Tedarikçi seçimi, Havayolu

1. INTRODUCTION

Technology and information have been constantly renewing themselves in recent years. Information that has always been used and led us in the right path in the past may not help us obtain the desired results once it losses its validity in current times. When one fails to obtain the desired outcome or when wants to proceed in the face of obstacles, the crucial point would be the ability to make quick decisions based on correct information. Thus all sectors need to monitor and obtain correct information and integrate their decision-making strategies with their businesses. And the most important phase of such integration is closely related to decision-making skills at the individual level. One needs to foresee the best outcome among all other alternatives and decision-making strategies need to be developed by adapting to developments in light of these foresights.

Decision-making is defined as making choices from among different alternatives. It is a type of skill needed when one needs to make correct decisions. For senior executives the most important factor helping to improve decision-making skills is improvement of the value of the decision. (Koç and Topaloğlu, 2010).

In addition to their easily foreseeable outcomes, all available alternatives would also have other outcomes that may go easily unnoticed and cannot be explained numerically. Conducting an analysis of these outcomes to figure out the option with the highest contribution is a cumbersome and time-consuming process for the decision maker. Decision maker usually incorporates his/her insights to the process in order to comprehend the factors (Yuluğkural, 2001)

Decision-making lies in the heart of managerial processes of most businesses. Issues like defining the business, timing of business, and who will be doing the business and defining the resources to be used, usually require making decisions in advance. If there were limited use of limited resources that are hard to access, there wouldn't be any issue of making important decisions for the whole world. The higher the number of goals, the more difficult would be the decision making process. Management of the decision-making processes is the most important task for a senior executive and for all businesses the main goal would be making the optimum decision and implementing these decisions as effectively as possible.

This paper will research Multi-criteria decision making (MCDM) and logistics issues and their sub titles simultaneously.

2. SUPPLIER SELECTION

In the traditional approach, supplier selection focuses on price, flexibility and quality. Today, in addition to these parameters sustainability plays a crucial role as the procurement process has become much more complicated due to environmental and social pressure on the supply chain. Supplier selection, monitoring and controlling of the process has become much more important than supplier integration and development in terms of improving sustainability. It is also very clear that there must be greater emphasis on social aspects of supply chain and that there are many things that need to be accomplished. (Mani et al., 2014)

Today, industrial establishments produce items that incorporate numerous physical components. With products offering more and more features, the number and types of parts used has proliferated. It is less costly for businesses to produce all the parts used in their products. Thus, businesses use vendors to obtain some of the parts they need in their products. The vendors from which businesses obtain the parts they use in the production process are called suppliers.

The main goal of supplier evaluation process is to minimize the procurement risks and to maximize the total value for the buyer. The buyer company should be selecting suppliers with whom it may enter into long term business relations. Suppliers need to demonstrate constant improvement in order to meet the current and future needs and expectations of the buyers.

Despite the use of some common evaluation criteria in selecting and evaluating suppliers, evaluation methods tend to differ among buyers due to differing needs and expectations of the businesses.

There are two methods used in supplier selection:

Supplier Selection in a Setting Offering Alternatives: Options are evaluated based on the predefined performance criteria of a business before a decision is made. After the weight for each criteria is defined, for each alternative value, criteria weight are calculated resulting in the supplier offering the maximum value.

Supplier Selection Based on Performance: In this method, suppliers are selected based on evaluation of supplier performance within the company and their distribution performances (Demirdöğen and Küçük, 2007).

3. MULTI-CRITERIA DECISION MAKING METHODS

3.1. Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP), is one of the multi-criteria decision analysis methods designed to help individuals to make better decision in complex cases that involve traumas caused by pros and cons of numerous alternatives. [10]

AHP proposes a mathematical model of the decision making process and is used in solving complex problems. Despite AHPs roots in 1980s, decision-making processes were already known with comparative judgments and similar analysis techniques. Accordingly, law of comparative judgment was first proposed by Thurstone in 1927. In this method, alternatives are compared as being bigger, better, more negative and better looking and alternatives are shown on a numerical axis based on these analyses (Turgut & Baykul, 1992). Numerous techniques have been developed for analysis of multi-criteria decision-making methods. With AHP, in order to determine the significance level of each criterion, first their weights need to be determined. After that criteria and these weights are used together to make the best selection among alternatives. AHP ranks decision alternatives based on their level of significance. AHP is a powerful and easy-to-understand method that allows groups and individuals to combine numerical and verbal factors in their decision-making processes. (Pamukçu, 2003)

Basically, AHP method focuses on evaluating alternatives by developing priorities for the alternatives and criteria. These priorities are generated from the proportional values of alternatives if these alternatives are measured on a scale, and if not, they are generated based on judgments made based on the comparative judgment process. With AHP, a problem with multi-dimensional scale is converted into a problem with a single dimension (Saaty and Vargas, 2012)

AHP is one of the multi-criteria decision analysis methods designed to help individuals to make better decision in complex cases that involve traumas caused by pros and cons of numerous alternatives. AHP analysis is defined below: (Singh et al., 2006)

The first step involves defining the criteria to be used to determine the goal of the decision, possible alternatives and how well the alternatives can be expected to reach that goal. In addition, different decision situations and / or scenarios can be defined as well. Then these decision factors are rearranged into a hierarchical decision models with the goal at the top, alternatives at the bottom and criteria in the middle. The model serves as a framework for summarizing the decision problem and dividing the decision into smaller and more manageable components for future analysis.

In the second phase of AHP analysis, information regarding how well the alternatives can be to meet decision criteria is gathered and summarized.

In the third step, alternatives' ability to meet the decision criteria is evaluated and the importance of the criteria based on the decision goal is determined. If the model involves different decision perspectives or scenarios, separate evaluations would be made for each.

In the third phase, abilities of the alternatives to meet criteria are evaluated and the significance of the criteria in relation to the decision goal is evaluated. If the model involves different decision perspectives or scenarios, separate evaluations would be made for each. Then Comparative judgments are formed in order to make all these decisions. After all comparisons are made a normalized proportion scale called "Normalized Matrix" that summarizes the outcomes of all direct and indirect comparisons between decision factors is formed. Internal consistency of the decisions within a series of comparative judgments is obtained routinely using a scale named consistency rate. A consistency rating of 0 indicates perfect consistency. Based on general rules, consistency rates below 0.1 are deemed as acceptable.

In the fourth step of AHP, the scales created in the third step are combined to come up with a summary score that indicates how well the alternatives can be expected to reach the goal. This is done in fashion similar to calculating weighted average whereby multiplying the alternative priorities assigned to criteria with scores indicating how well they meet the criteria and adding the outcomes. Outcome scores, which are added to 1 and are usually expressed as percentages demonstrates the alternative's relative ability to reach the decision goal.

3.2. Topsis

TOPSIS method was developed by Hwang and Yoon (1981) to solve MCDM problems that are based on the theory that the chosen alternative should have the shortest distance from positive ideal solution (A*) and the farthest distance from the negative ideal solution (A−). For instance, the positive ideal solution maximizes functionality and minimizes cost while the negative ideal solution maximizes cost and minimizes functionality. With TOPSIS method, performance ratings and criteria weights are given as absolute values. In recent years, numerous interesting projects focusing on TOPSIS method have been implemented in a wide range of areas including supplier selection, tourism destination rating, financial performance rating, location selection, company evaluation and ranking carrier alternatives (Hanine et al. 2016).

Then the distances of all alternatives from positive and negative ideal solutions are calculated. The main goal here is to ensure that the selected alternative has the minimum distance to the positive ideal solution and the maximum distance from the negative ideal solution. In other words, the alternative that is closest to the positive ideal solution is also the farthest from the negative ideal solution.

TOPSIS method was built on the foundations of ELECTRE method. Thus, both methods have the same initial two steps. In both methods the process starts with standardization of the decision matrix and in the second step weights for criteria are obtained from the decision maker. Two methods diverge after these steps. While TOPSIS indicates that the alternative that is closest to ideal solution and farthest from the negative ideal solution is the optimum one, ELECTRE filters alternative based on superiority of alternatives to each other (Dumanoğlu, 2010).

3.3. VIKOR

VIKOR method provides the optimum ranking of alternatives and alternative selection calculation based on many criteria (Opricovic and Tzeng, 2004).

First proposed by Opricovic, VIKOR method was included by Opricovic and Tzeng in the multi criteria decision-making problems. VIKOR stands for Vise Kriterijumska Optimizacija I Kompromisno Resenje. It means multi-criteria optimization and agreed solutıon. The goal of this method is to develop an agreed solution based on alternatives using the judgment criteria. Agreed solution is the one closest to the ideal solution (Chu et al., 2007).

3.4. Comparison of TOPSIS and VIKOR Methods

Both methods assume a scale factor for all criteria. This scale requires all criteria values to be removed for all different units. An addition is calculation is made to rank all values calculated with the methods. The main difference between the two methods is observed in their approaches. VIKOR method offers an addition calculation that represents the distances from the ideal solution. Just like TOPSIS, VIKOR method as well offers an advantageous consensus solution. Normalization procedures are different in two methods. VIKOR method uses linear normalization while TOPSIS method uses vector normalization. In linear normalization, normalized value is not dependent on the relations between criteria. In TOPSIS method, the normalized value can be different when a different evaluation is made among criteria. TOPSIS introduces the ranking index, which also includes the distances from the ideal, and negative ideal solution point and, these distances in TOPSIS are summed simply without summarizing but only by taking into account the relative significance of these distances.

TOPSIS method uses the Euclid distance with n dimensions, which can represent some on its own. It provides the balance between total satisfaction and individual satisfaction however its weights are termed using letter v and are used in a different way than in VIKOR. Both methods offer a ranking list, meaning both are ranking methods. In VIKOR, the alternative at the top of the rank indicates the value closest to the ideal solution. In TOPSIS, the alternative at the top of the rank is the best in the ranking index but isn’t always necessarily the closest to the ideal solution. In addition, in terms of ranking, VIKOR method offers an advantageous consensus solution (Sarı, 2018).

4. LITERATURE SURVEY

Literature survey has shown that Multi-Criteria Decision Making, AHP and TOPSIS methods are used together and separately. Literature survey has analyzed studies done between 2013-2018. Below are some of the studies where AHP and TOPSIS methods are used together and separately in Multi-Criteria Decision Making processes.

In one study, Awasthi and Chauhan (2012:573-584) used AHP and fuzzy TOPSIS methods simultaneously for city logistics planning. A total of 16 sub-criteria under 4 main criteria were used. These four criteria were technical, social, economic and environmental criteria. First the weights were calculated using the AHP 30 method and then the fuzzy TOPSIS method was applied.

In two separate studies, Agasisti (2013) used the data envelopment analysis to measure effectiveness of mid schools in Italy and again Agasisti (2014) used the same method to measure public spending for education in 20 European countries.

In one study, Manap Davras and Karaatlı (2014) used AHP and BAHP methods simultaneously for supplier selection for hotels.

In another study, Kolios, Mytilinou, Lozano-Minguez and Salonitis introduced a new extended version of the Multi-Criteria Decision Making (MCDM) methods that takes into account the stochastic input variables. The results of this study were assesses using TOPSIS and PROMETHEE methods.

In one study, Uslu, Kızıloğlu, İşleyen and Kahya proposed a new solution approach that involves Analytical Hierarchy Process and TOPSIS methods based on Geographical Information System (GIS) in order to determine the best location for a planned elementary school.

In another study, Avcı and Çınaroğlu aimed to develop a ranking of 5 leading airline companies in Europe based on their financial performances between 2012-2016. AHP (The Analytic Hierarchy Process) and TOPSİS (Technique for Order Preference by Similarity to Ideal Solutions) methods were used to rank the airline companies based on their financial performances.

5. ANALYSIS OF DECISION PROBLEM

In this study, the information technology department of the airline company aims to reveal how software selection is determined by multi-criteria decision making techniques. The universe of the study consisted of all airline companies in Turkey. The sample of the study is one of Turkey's leading airline.

In the research, supplier selection was made by using real data obtained from airline company. In the selection process of the supplier, a new mobile application is required. During the airline supplier selection process, as a result of the review among 20 supplier companies, the number of companies was reduced to three according to mobile application writing experience.

In this study, while the supplier selection process of the beneficiary is evaluated, MCDM methods are used. Among these methods, AHP, TOPSIS and VIKOR techniques were applied. AHP method was used to determine criteria weights in the supplier selection process of airline IT department. For this purpose it is primarily designed decision problem. Then, the data collection phase was started for the designed problem. During the data collection stage, a questionnaire was prepared by the decision-making group, in which the importance of the criteria was evaluated mutually.

The questionnaire was designed to perform binary comparisons. It refers to the pairwise comparison of the criteria in the hierarchy in order to determine the relative importance of the criteria according to the higher level criteria. In binary comparisons, when asked to the decision-maker how important A criteria is compared to B criteria, the decision maker evaluates the comparisons according to the 1-9 Preference Scale.

In this study, airline supplier selection process was analyzed using MCDM methods. Comparison was made by working with 3 real firms. Then, the number of firms (N) was increased by applying simulation and IT department supplier selection application was made for 50 firms. After the weights were determined with AHP, supplier selection analysis was performed using TOPSIS and VIKOR methods.

5.1. Solution of Analytic Hierarchy Process with Excel

While solving problems with AHP, matrix operations of problems, Ms Excel, Expert Choice, Super Decision, etc. methods are used. Table 1 compares the main criteria.

Table1.Comparison Matrix (Question 1)

	Instituonal Competence Level	Project Solution
Instituonal Competence Level	1	0,129
Project Solution	7,760	1
Total	8,760	1,129

Decision matrix is created by entering the data given in the problem into Excel. After the decision matrix is created, the process of calculating the Normalized Matrix, which is Step 2, proceeds.

C6 cell = GEOMEAN (Survey 1'! C5; 'Survey 2'! C5; 'Survey 3'! C5; ' Survey 4'! C5; ' Survey 5'! C5), D5 cell = GEOMEAN (' Survey 1' ! D4; 'Survey 2'; D4; 'Survey 3'; D4; 'Survey 4'! D4; 'Survey 5'! D4), C7 cell = C5 + C6, D7 cell = D5 + D6

After data entry in Excel, column totals are taken to calculate the normalized matrix. The Excel formulations of the respective operations under each column are described above.

Table 1. Normalized Matrix

	Institutional Competence Level	Project Solution	Priority Vector/ Row Mean
Institutional Competence Level	0,11	0,110	0,11
Project Solution	0,890	0,89	0,89
	1,000	1,000	1,000

Each column element is divided by the corresponding column total.

C11 cell = C5 / $ C $ 7, C12 cell = C6 / $ C $ 7, D11 cell = D5 / $ D $ 7, D12 cell = D6 / $ D $ 7, E11 cell = AVERAGE (C11: D11), E12 cell = AVERAGE (C12: D12), C13 cell = SUM (C11: C12), D13 cell = SUM (D11: D12), E13 cell = SUM (E11: E12)

Definitions of formulas in all cells were made. The weight of the Institutional Competence Level according to the priorities vector was 0,11, while the weight of the Project Solution was calculated as 0.89. In the next step, it is calculated whether the comparisons are inconsistent. Excel's MMULT function is used to calculate the matrix of all priorities. All priorities matrix is obtained by multiplying the averages with the comparison matrix. The operations are shown in Figure 3.

Table 2. All Priorities Matrix

All Priorities Matrix		Division of Priorities Vector
	0,229	2
	1,771	2
		2

0,229; B15 cell = DCARP (C5: D6; E11: E12), B16 cell = MMULT (C5: D6; E11: E12), C15 cell = B15 / E11, C16 cell = B16 / E12, C17 cell = AVERAGE (C15: C16)

After, the values of the all priorities matrix are divided by the average values individually. The average of the values obtained gives the max value. The same procedure is repeated for all criteria.

Weights of Field Expertise and References criteria were calculated as 63% and 37%, respectively. Weights of Company Age, Mobile Application Development Turnover, Mobile Application Turnover Rate, Mobile Application Developed Platform Richness and Total Mobile Team Personnel criteria are given in the table. Weights of Qualified Applications and References Evaluation Score criteria were calculated as 75% and 25%, respectively. Satisfaction of Requirements, Technical Competence of the Project Team, Summary of Technical Solution, Draft Project Plan, Hosting Solution and Ticket Sales Prototype criteria are included in the Table 4.

Table 3. Weights of Criterias

Main Criterias	Sub-Criterias	Sub-Criterias	Weights
Institutional Competence Level			0,11
	Field Expertise		0,63
		Company Age	0,06
		Mobile Application Development Turnover	0,13
		Mobile Application Turnover Rate	0,35
		Mobile Application Developed Platform Richness	0,25
		Total Mobile Team Personnel	0,20
	References		0,37
		Qualified Applications	0,75
		References Evaluation Score	0,25
Project Solution			0,89
	Satisfaction of Requirements		0,40
	Technical Competence of the Project		0,23
	Summary of Technical Solution		0,11
	TeamDraft Project Plan		0,10
	Hosting Solution		0,10
	Ticket Sales Prototype		0,05
			0,11

As a result of the comparisons, the weight values of the criteria found are shown in the figure above. Among the main criteria, it can be said that the Project Solution has a higher rate. Among the sub-criteria, Field Expertise and the Satisfaction of Requirements have the highest rates. Among the sub-criteria, Mobile Application Turnover Rate and Qualified Applications have been calculated as having the highest rate.

5.2. TOPSIS Solution with Excel

In this study, after weights of criteria were determined with AHP method, TOPSIS method, which is one of the methods used for supplier selection, was obtained. Using the weights of the criteria obtained with AHP, the TOPSIS solution process is shown in the following figures in the order of processing.

Table 4. TOPSIS Decision Matrix

Weights	0,09	0,24	0,28	0,2	0,17	0,87	0,12	0,4	0,22	0,1	0,1	0,05	0,11
	Company Age	Mobile Application Development Turnove	Mobile Application Turnover Rate	Mobile Applicati Developed Platfo Richness	Total Mobile Team Personnel	Qualified Applicatio	References Evaluation Score	Satisfaction Requirement	Technical Competen e of the Project	Summary o Technical Solution	TeamDraf Project Pla	Hosting Solution	Ticket Sale Prototype
1	100	100	100	100	100	90	70	88	47	20	50	70	90
2	70	29,3	100	100	77,6	85	70	97	28	0	60	80	55
3	100	31,7	1	100	46,1	50	70	82	54	85	40	80	45
4	90	94	63	100	93	67	70	89	37	64	45	72	52
5	74	63	38	101	69	57	71	85	35	34	56	76	45
46	89	53	89	142	76	56	112	92	53	1	42	79	78
47	89	54	9	143	64	60	113	82	40	70	40	77	46
48	72	75	43	144	53	75	114	89	37	62	47	78	90
49	96	43	71	145	50	80	115	89	42	26	48	78	71
50	87	54	80	146	71	71	116	91	51	30	46	77	71

The decision matrix is formed at the beginning of the supplier selection process. The lines of the decision matrix show the alternatives and the columns of the decision matrix show the criteria.

Table 5. Decision Matrix Normalization Process

Weights	0,09	0,24	0,28	0,2	0,17	0,87	0,12	0,4	0,22	0,1	0,1	0,05	0,11
	Company Age	Mobile Application Development Turnove	Mobile Application Turnover Rate	Mobile Applicati Developed Platfo Richness	Total Mobile Team Personnel	Qualified Applicatio	References Evaluation Score	Satisfaction Requirement	Technical Competen e of the Project	Summary o Technical Solution	TeamDraf Project Pla	Hosting Solution	Ticket Sale Prototype
1	10000	10000	10000	10000	10000	8100	4900	7744	2209	400	2500	4900	8100
2	4900	858,49	10000	10000	6021,76	7225	4900	9409	784	0	3600	6400	3025
3	10000	1004,89	1	10000	2125,21	2500	4900	6724	2916	7225	1600	6400	2025
4	5776	5625	6084	10000	4356	4900	4900	7744	1369	4096	2025	5184	2704
5	6724	961	8649	10201	6724	3844	5041	7056	1225	1156	3136	5776	2025
46	9025	3136	1369	20164	8464	3969	12544	7744	2809	1	1764	6241	6084
47	6724	9604	4624	20449	3600	7569	12769	8100	1600	4900	1600	5929	2116
48	7744	481	16	20736	9604	3969	12996	8464	1369	3844	2209	6084	8100
49	10000	2916	5041	21025	4096	7521	13225	8100	1764	676	2304	6084	5041
50	9801	3364	1156	21316	3721	6724	13456	9025	2601	900	2116	5929	5041
SQRT-TOTAL	599,27	495,66	411,62	865,86	535,12	504,88	655,63	624,22	304,56	361,79	346,56	532,24	488,81

The square root of the sum of the squares of the values of each criterion of the decision matrix is calculated and the normalization process is completed by dividing the respective element of the column by the resulting value.

For cell B113; = SQUARE (SUM (B63: B112)) for C113 cell; = SQUARE (SUM (C63: C112)) is copied to the G113 cell by dragging the same formula.

Table 6. TOPSIS Normalized Matrix

	Company Age	Mobile Application Development Turnove	Mobile Application Turnover Rate	Mobile Applicati Developed Platfo Richness	Total Mobile Team Personnel	Qualified Applicatio	References Evaluation Score	Satisfaction Requirement	Technical Competen e of the Project	Summary o Technical Solution	TeamDraf Project Pla	Hosting Solution	Ticket Sale Prototype
1	0,167	0,213	0,252	0,115	0,192	0,177	0,106	0,138	0,164	0,063	0,147	0,132	0,182
2	0,116	0,062	0,252	0,115	0,149	0,167	0,106	0,152	0,097	0	0,176	0,15	0,111
3	0,166	0,067	0,002	0,115	0,088	0,099	0,106	0,129	0,188	0,27	0,118	0,15	0,091
4	0,128	0,183	0,058	0,115	0,153	0,17	0,106	0,148	0,156	0,031	0,156	0,149	0,157
5	0,129	0,162	0,005	0,163	0,143	0,12	0,169	0,141	0,115	0,054	0,147	0,147	0,149
46	0,126	0,072	0,179	0,164	0,128	0,136	0,17	0,137	0,111	0,099	0,12	0,133	0,18
47	0,151	0,102	0,181	0,165	0,167	0,177	0,171	0,151	0,111	0,159	0,144	0,145	0,153
48	0,163	0,175	0,045	0,166	0,09	0,102	0,172	0,152	0,181	0,229	0,15	0,143	0,143
49	0,166	0,168	0,159	0,167	0,16	0,128	0,173	0,132	0,108	0,076	0,15	0,139	0,135
50	0,145	0,153	0,103	0,168	0,101	0,102	0,174	0,137	0,184	0,184	0,135	0,15	0,117

Each alternative value is divided by the square root of the sum of the squares and the normalized matrix values are obtained by the following formulas.

For B20 cell; = B8 / $ B $ 113 for Cell B21; = B9 / $ B $ 113,

All operations are completed by copying.

Table 7. TOPSIS Weighted Normalized Matrix

	Company Age	Mobile Application Development Turnove	Mobile Application Turnover Rate	Mobile Applicati Developed Platfo Richness	Total Mobile Team Personnel	Qualified Applicatio	References Evaluation Score	Satisfaction Requirement	Technical Competen e of the Project	Summary Technical Solution	TeamDraf Project Pla	Hosting Solution	Ticket Sale Prototype
1	0,014	0,048	0,07	0,023	0,033	0,16	0,012	0,055	0,033	0,005	0,014	0,006	0,02
2	0,01	0,014	0,07	0,023	0,025	0,151	0,012	0,061	0,019	0	0,016	0,007	0,012
3	0,014	0,015	0	0,023	0,015	0,089	0,012	0,051	0,037	0,022	0,011	0,007	0,01
4	0,013	0,029	0,009	0,023	0,018	0,116	0,012	0,053	0,026	0,007	0,014	0,007	0,011
46	0,014	0,331	0,063	0,032	0,023	0,144	0,02	0,06	0,028	0,018	0,015	0,006	0,017
47	0,012	0,018	0,002	0,033	0,026	0,089	0,02	0,054	0,03	0,016	0,015	0,007	0,019
48	0,01	0,042	0,028	0,033	0,015	0,128	0,02	0,056	0,02	0,021	0,013	0,006	0,018
49	0,011	0,048	0,018	0,033	0,026	0,144	0,021	0,058	0,036	0,002	0,015	0,007	0,017
50	0,012	0,021	0,03	0,033	0,019	0,11	0,021	0,059	0,028	0,019	0,014	0,006	0,019
IDEAL SOLUTION	0,014	0,048	0,07	0,033	0,033	0,16	0,021	0,061	0,037	0,022	0,016	0,007	0,02
NEGATIVE IDEAL SOLUT	0,01	0,014	0	0,023	0,015	0,089	0,012	0,051	0,019	0	0,011	0,006	0,01

The values of each alternative according to the criteria are multiplied by the weights of the relevant criterion to obtain the Weighted Normalized Matrix as shown in Table 8.

For cell B176; = $ B $ 5 * B120 for cell B177; = $ B $ 5 * B121,

Then all cells are copied to the same process.

Two new cells are added to the end of the matrix: Ideal Solution Values and Negative Ideal Solution Values. The objective is to find the maximum of the Ideal Solution Values, the minimum of the Negative Ideal Solution Values.

For cell B226-B227; = MAX (B176: B225) for C226-C227 cell; = MAX (C176: C225)

The process is copied to the other cells in the same row.

For cell B228-B229; = MIN (B176: B225) for C228-C229 cell; = MIN (C176: C225)

The process is copied to the other cells in the same row.

Table 8. TOPSIS Calculation of Distance to Ideal and Non-Ideal Points

	Company Age	Mobile Application Development Turnove	Mobile Application Turnover Rate	Mobile Applicati Developed Platfo Richness	Total Mobile Team Personnel	Qualified Applicatio	References Evaluation Score	Satisfaction Requirement	Technical Competen e of the Project	Summary Technical Solution	TeamDraf Project Pla	Hosting Solution	Ticket Sale Prototype	TOTAL	SQRT
1	0	0	0	0,0001	0	0	0,00007	0,00003	0,00002	0,0004	0	0	0	0,0006	0,026
2	0,00001	0,001	0	0,0001	0,0005	0,00007	0,00007	0	0,0003	0,0007	0	0	0,00006	0,002	0,052
3	0	0,001	0,004	0,0001	0,0003	0,004	0,00007	0,000009	0	0	0,00003	0	0,0001	0,0108	0,104
4	0,000001	0,000001	0,003	0,0001	0,0001	0	0,00007	0,00004	0,0002	0,0005	0,00002	0	0,00003	0,005	0,072
46	0,00001	0,0008	0,003	0	0,0002	0,0011	0	0,00006	0	0,0003	0	0	0,00006	0,006	0,077
47	0,00001	0,0001	0,0003	0	0,0001	0,002	0	0	0,0001	0,0005	0,00001	0	0,00003	0,004	0,065
48	0,000001	0,001	0,001	0	0,0003	0,0001	0	0,0003	0	0,0003	0	0	0	0,003	0,059
49	0	0,0006	0,0003	0	0,0001	0,0005	0	0,00007	0	0,0006	0	0	0	0,0025	0,05
50	0,00001	0,0007	0,0001	0	0,00005	0,0004	0	0	0,0002	0,0003	0	0	0,00002	0,001	0,044

For cell B236; = (B176- $ B $ 226) ^ 2 for C236 cell; = (C176- $ C $ 226) ^ 2

These operations are repeated for all cells. For the two new columns that were opened, the total of all rows were taken first and then the square root of their totals.

For O236 cell; = SUM (B236: N236), for P236 cell, = SQUARE (O236),

These operations are repeated for all rows.

Table 9. TOPSIS Negative Ideal Distance Table

	Company Age	Mobile Application Development Turnove	Mobile Application Turnover Rate	Mobile Applicati Developed Platfo Richness	Total Mobile Team Personnel	Qualified Applicatio	References Evaluation Score	Satisfaction Requirement	Technical Competen e of the Project	Summary Technical Solution	TeamDraf Project Pla	Hosting Solution	Ticket Sale Prototype	TOTAL	SQRT
1	1,936E-05	1,094E-03	4,44E-03	0	2,96E-04	4,99E-03	0	1,43E-05	1,86E-04	3,16E-05	7,95E-06	0	1,02E-04	0,011	0,105
2	0	0	4,44E-03	0	1,01E-04	3,82E-03	0	8,92E-05	0	0	3,18E-05	8,77E-07	5,04E-06	0,008	0,092
3	1,936E-05	1,26E-06	0	0	0	0	0	0	3,48E-04	5,70E-04	0	8,77E-07	0	0,0009	0,03
4	1,936E-05	1,93E-04	1,80E-03	0	8,56E-07	2,62E-03	0	6,70E-05	2,27E-04	9,12E-05	6,44E-06	5,61E-07	9,31E-05	0,0051	0,071
5	5,378E-07	9,74E-04	2,10E-03	5,34E-08	1,17E-04	1,38E-03	3,35E-08	5,71E-05	2,49E-04	5,17E-04	1,15E-05	7,11E-07	5,82E-05	0,0054	0,073
46	0	3,81E-04	3,43E-03	9,41E-05	3,64E-05	1,650-03	5,91E-05	1,43E-05	1,29E-05	3,44E-04	1,15E-05	8,77E-09	2,22E-05	0,006	0,077
47	1,138E-05	7,04E-04	1,31E-04	9,87E-05	8,56E-07	1,38E-03	6,19E-05	9,91E-06	2,49E-04	1,26E-04	5,09E-06	3,51E-08	8,51E-06	0,0027	0,052
48	3,098E-06	8,07E-04	1,42E-03	1,03E-04	8,50E-05	2,81E-05	6,49E-05	3,96E-07	4,17E-05	3,23E-04	1,56E-05	0	3,95E-05	0,0029	0,054
49	3,636E-06	7,80E-04	7,99E-04	1,08E-04	3,26E-05	3,20E-03	6,78E-05	2,54E-05	3,29E-05	6,63E-05	3,18E-05	2,19E-07	6,09E-06	0,0051	0,071
50	8,605E-08	4,18E-04	2,83E-04	1,13E-04	6,31E-05	3,12E-04	7,09E-05	9,91E-06	5,15E-05	3,16E-05	3,90E-06	3,16E-07	2,22E-05	0,0013	0,037

For cell B291; = (B176- $ B $ 228) ^ 2 for C291 cell; = (C176- $ C $ 228) ^ 2

These operations are repeated for all cells. For the two new columns that were opened, the total of all rows were taken first and then the square root of their totals.

For O291 cell; = SUM (B291: N291) for cell P291, = SQUARE (O291), These operations are repeated for all rows.

Table 10. TOPSIS Ideal and Negative Ideal Solution Values Table

	Ideal Solution	Negative Ideal Solution
1	0,025	0,102
2	0,049	0,088
3	0,102	0,031
4	0,078	0,034
45	0,057	0,069
46	0,032	0,082
47	0,061	0,071
48	0,089	0,035
49	0,074	0,048
50	0,045	0,078

The Ideal and Negative Ideal Solution Values Table contains the values in the square root column of Table 9 and Table 10. The objective here is to calculate the shortest distance to the ideal solution and the shortest distance to the negative ideal solution.

Table 11. TOPSIS Result Table

	Ideal Solution	Negative Ideal Solutio	Relative proximity Ideal Solution	Ranking
1	0,025	0,106	0,81	1
2	0,049	0,092	0,65	8
3	0,102	0,031	0,23	48
4	0,078	0,059	0,43	34
5	0,068	0,049	0,42	38
6	0,053	0,065	0,55	15
7	0,049	0,071	0,59	13
8	0,082	0,042	0,34	38
9	0,058	0,068	0,54	16
10	0,04	0,078	0,66	7
11	0,084	0,049	0,37	34
12	0,054	0,065	0,55	13
13	0,082	0,04	0,33	35
14	0,072	0,054	0,43	31
15	0,048	0,066	0,58	12
16	0,038	0,079	0,68	4
17	0,067	0,071	0,51	15
18	0,072	0,066	0,48	20
19	0,049	0,073	0,60	9
20	0,06	0,058	0,49	18
21	0,047	0,074	0,61	8
22	0,036	0,084	0,70	3
23	0,085	0,029	0,25	28
24	0,057	0,06	0,51	13
25	0,044	0,08	0,65	6
26	0,069	0,052	0,43	19
27	0,076	0,059	0,44	18
28	0,07	0,052	0,43	19
29	0,054	0,079	0,59	6
30	0,089	0,035	0,28	21
31	0,069	0,075	0,52	9
32	0,065	0,057	0,47	12
33	0,077	0,04	0,34	16
34	0,045	0,084	0,65	5
35	0,03	0,086	0,74	2
36	0,039	0,077	0,66	3
37	0,029	0,089	0,75	1
38	0,065	0,074	0,53	3
39	0,066	0,056	0,46	8
40	0,069	0,073	0,51	4
41	0,04	0,081	0,67	1
42	0,065	0,055	0,46	6
43	0,08	0,04	0,33	7
44	0,072	0,071	0,50	4
45	0,062	0,07	0,53	2
46	0,093	0,044	0,32	5
47	0,069	0,052	0,43	4
48	0,055	0,065	0,54	1
49	0,061	0,062	0,50	1
50	0,072	0,062	0,46	1

When the result table is interpreted, it is seen that the most appropriate alternative is Company 1.

5.3. Solution of VIKOR Method with Excel

While solving the problem with VIKOR, it tried to choose the most suitable decision alternatives with the best performance. VIKOR method and supplier selection stages were performed in Excel and the results were explained.

Table 12: VIKOR Decision Matrix

Weights	0,09	0,24	0,28	0,2	0,17	0,87	0,12	0,4	0,22	0,1	0,1	0,05	0,11
	Company Age	Mobile Application Development Turnover	Mobile Application Turnover Rate	Mobile Application Developed Platform Richness	Total Mobile Team Personnel	Qualified Applications	References Evaluation Score	Satisfaction of Requirements	Technical Competence of the Project	Summary of Technical Solution	TeamDraft Project Plan	Hosting Solution	Ticket Sales Prototype
1	100	100	100	100	100	90	70	88	47	20	50	70	90
2	70	29,3	100	100	77,6	85	70	97	28	0	60	80	55
3	100	31,7	1	100	46,1	50	70	82	54	85	40	80	45
4	84	52	87	94	49	64	69	85	34	4	50	78	65
5	82	99	55	96	56	77	69	96	28	4	43	78	56
45	73	37	53	93	71	70	72	93	52	54	43	73	73
46	90	81	7	98	68	65	72	82	43	67	54	75	89
47	95	71	65	96	93	53	66	95	53	84	52	76	62
48	74	89	89	100	51	76	70	91	37	56	44	79	82
49	76	78	38	95	92	82	69	96	33	67	41	74	51
50	78	85	37	92	68	53	72	92	46	76	52	78	53

The decision matrix is formed at the beginning of the supplier selection process.

Table 13: VIKOR Determination of Best and Worst Values

Weights	0,09	0,24	0,28	0,2	0,17	0,87	0,12	0,4	0,22	0,1	0,1	0,05	0,11
	max	max	max	max	max	max	max	max	max	max	max	max	max
	Company Age	Mobile Application Development Turnover	Mobile Application Turnover Rate	Mobile Application Developed Platform Richness	Total Mobile Team Personnel	Qualified Applications	References Evaluation Score	Satisfaction of Requirements	Technical Competence of the Project	Summary of Technical Solution	TeamDraft Project Plan	Hosting Solution	Ticket Sales Prototype
1	100	100	100	100	100	90	70	88	47	20	50	70	90
2	70	29,3	100	100	77,6	85	70	97	28	0	60	80	55
3	100	31,7	1	100	46,1	50	70	82	54	85	40	80	45
4	85	96	6	94	51	58	68	94	41	27	55	77	58
5	92	67	16	95	73	58	74	85	43	81	59	71	68
45	70	86	15	93	52	77	70	85	32	50	56	79	70
46	87	57	25	97	48	87	72	85	35	44	51	70	86
47	85	97	36	94	73	67	66	91	43	78	43	71	82
48	89	66	72	90	52	87	67	83	48	76	52	76	61
49	72	32	70	99	98	83	69	85	45	45	58	79	72
50	76	77	94	99	85	65	74	85	39	51	43	74	50
Best	100	100	100	100	100	90	75	97	54	85	60	80	90
Worst	70	29,3	1	90	46,1	50	65	82	28	0	40	70	45

Minimum and maximum values were determined for each of the criteria. First best value for 100; For cell B113; = MAX (B63: B112) The same operation is repeated for the entire line. For cell B114; = MIN (B63: B112) The same operation is repeated for the entire line.

Table 14. VIKOR Normalized Matrix

Weights	0,09	0,24	0,28	0,2	0,17	0,87	0,12	0,4	0,22	0,1	0,1	0,05	0,11
R	max	max	max	max	max	max	max	max	max	max	max	max	max
	Company Age	Mobile Application Development Turnover	Mobile Application Turnover Rate	Mobile Application Developed Platform Richness	Total Mobile Team Personnel	Qualified Applications	References Evaluation Score	Satisfaction of Requirements	Technical Competence of the Project	Summary of Technical Solution	TeamDraft Project Plan	Hosting Solution	Ticket Sales Prototype
1	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,600	0,269	0,765	0,500	1,000	0,000
2	1,000	1,000	0,000	0,000	0,416	0,125	0,000	0,000	1,000	1,000	0,000	0,000	0,778
3	0,000	0,966	1,000	0,000	1,000	1,000	0,000	1,000	0,000	0,000	1,000	0,000	1,000
4	0,933	0,509	0,889	0,000	0,928	0,450	0,000	0,933	0,308	0,412	0,750	0,000	0,778
5	0,533	0,113	0,768	0,000	0,074	0,375	0,000	0,133	0,769	0,059	0,650	1,000	0,956
45	0,900	0,919	0,808	0,000	0,668	0,400	0,000	0,133	0,769	0,600	1,000	0,300	0,844
46	0,833	0,297	0,576	0,000	0,798	0,075	0,000	0,133	0,154	0,718	0,050	0,400	0,578
47	0,267	0,778	0,192	0,000	0,872	0,025	0,000	0,933	0,692	0,988	0,850	1,000	0,333
48	0,233	0,198	0,798	0,000	0,167	0,850	0,000	0,533	0,615	0,071	0,250	0,000	0,156
49	0,400	0,113	0,202	0,000	0,631	0,650	0,000	0,867	0,000	0,718	0,100	0,200	0,222
50	0,467	0,594	0,061	0,000	0,167	0,200	0,000	0,400	0,308	0,612	0,700	1,000	0,333

Normalized matrix values for each cell were obtained by the following formulas.

For cell B122; = (B $ 113-B63) / (B-B $ 113 $ 114)

For C122 cell; = (C $ 113-C63) / (C-C $ 113 $ 114)

All cells are copied to the same process.

Table 15: VIKOR Weighted Normalized Matrix

Weights	0,09	0,24	0,28	0,2	0,17	0,87	0,12	0,4	0,22	0,1	0,1	0,05	0,11
	max	max	max	max	max	max	max	max	max	max	max	max	max
V	Company Age	Mobile Application Development Turnover	Mobile Application Turnover Rate	Mobile Application Developed Platform Richness	Total Mobile Team Personnel	Qualified Applications	References Evaluation Score	Satisfaction of Requirements	Technical Competence of the Project	Summary of Technical Solution	TeamDraft Project Plan	Hosting Solution	Ticket Sales Prototype
1	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,2400	0,0592	0,0765	0,0500	0,0500	0,0000
2	0,0900	0,2400	0,0000	0,0000	0,0706	0,1088	0,0000	0,0000	0,2200	0,1000	0,0000	0,0000	0,0856
3	0,0000	0,2319	0,2800	0,0000	0,1700	0,8700	0,0000	0,4000	0,0000	0,0000	0,1000	0,0000	0,1100
4	0,0870	0,1562	0,1046	0,0000	0,1577	0,1088	0,0000	0,3200	0,1946	0,0659	0,0300	0,0200	0,0147
5	0,0720	0,0034	0,0848	0,0000	0,0505	0,6960	0,0000	0,2667	0,0677	0,0718	0,0800	0,0050	0,0196
45	0,0300	0,1256	0,2121	0,0000	0,1293	0,0870	0,0000	0,2133	0,0254	0,0141	0,0800	0,0400	0,0122
46	0,0270	0,1697	0,1895	0,0000	0,0126	0,1305	0,0000	0,1867	0,1777	0,0224	0,0900	0,0450	0,0147
47	0,0510	0,1867	0,2178	0,0000	0,1419	0,2175	0,0000	0,4000	0,1777	0,0600	0,0550	0,0400	0,0416
48	0,0870	0,2240	0,1612	0,0000	0,0599	0,1523	0,0000	0,1867	0,0254	0,0788	0,0350	0,0000	0,0318
49	0,0540	0,0883	0,2659	0,0000	0,0883	0,8048	0,0000	0,0000	0,0762	0,0929	0,0900	0,0450	0,0733
50	0,0750	0,0679	0,2319	0,0000	0,0347	0,4133	0,0000	0,2667	0,1692	0,0706	0,0450	0,0400	0,0807

The values of each alternative according to the criteria are multiplied by the weights of the relevant criterion to obtain the Weighted Normalized Matrix as shown in Table 16.

For cell B182; = B $ 118 * B122

For C182 cell; C122 = C $ 118 *

The same procedure is repeated for all cells

Table 16: VIKOR Sİ, Rİ and Qi Values

			0	0,25	0,5	0,75	1
	Si	Ri	Qi (q=0,00)	Qi (q=0,25)	Qi (q=0,50)	Qi (q=0,75)	Qi (q=1,00)
1	0,4757	0,2400	0,0818	-0,1115	-0,2152	-0,1454	0,0000
2	0,9150	0,2400	0,0818	-0,0464	-0,0375	0,1147	0,2605
3	2,1619	0,8700	1,0000	1,1421	1,1983	1,1196	1,0000
4	1,7465	0,6960	0,7464	0,8033	0,8282	0,8000	0,7537
5	1,0282	0,2393	0,0808	-0,0308	0,0075	0,1815	0,3277
45	1,4031	0,3045	0,1759	0,1288	0,2349	0,4311	0,5500
46	1,0835	0,3698	0,2709	0,1853	0,1813	0,2694	0,3604
47	1,7705	0,7613	0,8415	0,9108	0,9137	0,8419	0,7679
48	1,1150	0,2400	0,0818	-0,0167	0,0435	0,2332	0,3792
49	1,4135	0,3200	0,1984	0,1550	0,2571	0,4438	0,5562
50	0,9908	0,2093	0,0371	-0,0840	-0,0425	0,1466	0,3055
	S-	0,476					
	S*	2,162					
	R-	0,184					
	R*	0,870					

S_i values were calculated by adding the values of each row of the weighted normalized matrix.

For cell B238; = SUM (B182: N182)

For cell B239; = SUM (B183: N183) Repeat this process for all cells.

The R_i values were calculated by taking the maximum of each row value of the weighted normalized matrix.

For C238 cell; = MAX (B182: N182)C239 hücresi için; =MAX(B183:N183) The same procedure is repeated for all cells. Qi values were calculated according to 5 different q values.

For cell D238; = ((D $ 236 * ($ B238- $ C $ 290)) / ($ C $ 291- $ C $ 290)) + (((1-D $ 236) * (C238- $ C $ 292)) / ($ C $ 293- $ C $ 292))

For E238 cell; = ((E $ 236 * ($ B238- $ C $ 290)) / ($ C $ 291- $ C $ 290)) + (((1-E $ 236) * (D238- $ C $ 292)) / ($ C $ 293- $ C $ 292))

For F238 cell; = ((F $ 236 * ($ B238- $ C $ 290)) / ($ C $ 291- $ C $ 290)) + (((1-F $ 236) * (E238- $ C $ 292)) / ($ C $ 293- $ C $ 292))

For G238 cell; = ((G $ 236 * ($ B238- $ C $ 290)) / ($ C $ 291- $ C $ 290)) + (((1-G $ 236) * (F238- $ C $ 292)) / ($ C $ 293- $ C $ 292))

For H238 cell; = ((H $ 236 * ($ B238- $ C $ 290)) / ($ C $ 291- $ C $ 290)) + (((1-H $ 236) * (G238- $ C $ 292)) / ($ C $ 293- $ C $ 292))

The same operations are repeated for the lines in progress.

The S* and S- values represent the maximum and minimum values in the S_i column.

The values R* and R- represent the maximum and minimum values in the column R_i.

Table 17: VIKOR Solutions and Ranking Results

	0	0,25	0,5	0,75	1
	Qi (q=0,00)	Qi (q=0,25)	Qi (q=0,50)	Qi (q=0,75)	Qi (q=1,00)
1	10	4	1	1	1
2	10	8	7	6	5
3	50	50	50	50	50
4	44	44	46	45	45
5	7	9	9	9	9
6	13	14	14	20	26
7	2	3	5	5	6
8	32	35	39	40	42
9	38	40	44	48	49
10	48	49	49	49	48
11	45	45	43	42	39
12	5	7	8	8	8
13	29	31	36	37	40
14	1	1	2	2	2
15	22	22	23	26	27
16	7	12	13	17	23
17	38	38	32	24	16
18	20	20	19	19	20
19	30	30	30	27	25
20	16	15	15	11	11
21	3	2	3	4	4
22	41	42	42	44	44
23	14	13	10	10	13
24	16	16	16	12	12
25	24	26	28	33	34
26	7	11	12	14	19
27	43	43	41	43	43
28	35	34	34	34	28
29	27	27	24	22	22
30	37	36	31	23	17
31	16	17	17	18	21
32	26	24	20	16	14
33	45	46	48	47	47
34	41	41	40	38	33
35	30	29	29	25	24
36	32	33	38	39	41
37	49	48	45	41	35
38	27	28	27	28	29
39	22	23	25	29	30
40	6	5	4	3	3
41	32	32	35	35	31
42	35	37	37	36	37
43	24	25	26	31	32
44	40	39	33	21	10
45	15	18	21	30	36
46	21	21	18	15	15
47	47	47	47	46	46
48	10	10	11	13	18
49	16	19	22	32	38
50	4	6	6	7	7

For the case v = 0, suppliers 10th firm and 50th firm appear to have an acceptable advantage.

For the case of v = 0.25, it is seen that the 4th firm and 9th firm suppliers have an acceptable advantage.

For the case of v = 0.50, suppliers 1st firm and 7th firm appear to have acceptable advantages.

For the case of v = 0.75, it is seen that the suppliers ranked 1st firm and 6th firm have an acceptable advantage.

For the case of v = 1, the suppliers in the 1st firm and 5th firm positions appear to have an acceptable advantage.

In this study, five different solution suggestions have been developed for different "v" values. According to five different solution proposals; In case v is 0, the 10th supplier is recommended, v is 0.25, the 4th supplier is recommended, and in the case of 0.50, 0.75 and 1, the 1st supplier is recommended as a workable supplier in line with the specified criteria and weights. The compromised solutions proposed by this study are able to evaluate the decision-maker at every risk and select the appropriate supplier or suppliers.

6. sCONCLUSION AND RECOMMENDATIONS

The airline industry is developing and growing day by day. The adaptation of the renewed technologies is one of the most advanced sectors. In this study, air transportation supplier selection process analysis was evaluated. The MCDM methods were used to evaluate the supplier selection process.

In the studies, it is seen that more than one method is used in a CCKV problem. In this thesis, an application has been realized by using AHP, TOPSIS, VIKOR, ARAS and MOORA among MCDM methods in Supplier Selection.

First of all, theoretical information about these techniques was given and then solutions related to the surveys were obtained.

Table 19 shows the supplier selected by using the TOPSIS and VIKOR methods after determining the crtier weights with AHP.

Table 18. Optimum Firm Results

	Optimum Firms For Techniques
TOPSIS	FIRM 1
VIKOR	FIRM 1

Using the weights of the criteria obtained by AHP, supplier selection was carried out by TOPSIS and VIKOR methods and the results of the solution stages in Excel are shown in Table 19. The result of all methods is 1. firm. However, because the simulation technique is applied, random numbers are renewed in every experiment and the results obtained vary.

While there are many studies in which the methods used in the study are used separately, the number of studies using AHP, TOPSIS, and VIKOR methods is limited. There are different areas or different problems in all studies. There are many different CCKV methods in airline companies. However, as a result of the researches, no studies have been found regarding the IT department supplier selection process in airline companies. This study aims to include subjects that are not in the literature. In addition, this study provides a resource for researchers who want to work on different topics.

REFERENCES

Avcı T., Çınaroğlu E. (2018). Ahp Temelli Topsis Yaklaşımı ile Havayolu İşletmelerinin Finansal Performans Değerlemesi. C.Ü. İktisadi ve İdari Bilimler Dergisi, Cilt 19, Sayı 1.

Chu, M.T., Shyu, J., Tzeng, G.H. & Khosla, R., (2007). Comparison Among Three Analytical Methods for Knowledge Communities Group Decision Analysis, Expert Systems with Applications, 33(4), 1011-1024.

Hanine, M., vd., (2016). Application of An Integrated Multi-Criteria Decision Making AHP-TOPSIS Methodology for ETL Software Selection. Springer Plus. 5/263

Günay, Z., Ünal, Ö.F. AHP-TOPSIS Yöntemi İle Tedarikçi Seçimi (Bir Telekomünikasyon Şirketi Örneği). PESA Uluslararası Sosyal Araştırmalar Dergisi. Cilt 2. Sayı 1.

Karaatlı, M., Ömürbek, N., Köse, G. (2014). Analitik Hiyerarşi Süreci Temelli TOPSIS ve VIKOR Yöntemleri İle Futbolcu Performanslarının Değerlendirilmesi. Dokuz Eylül Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi Cilt:29, Sayı:1.

Kaya Samut, P., (2014). İki Aşamalı Çok Kriterli Karar Verme ile Performans Değerlendirmesi: AHP ve TOPSIS Yöntemlerinin Entegrasyonu. Anadolu Üniversitesi Sosyal Bilimler Dergisi. Cilt.14. Sayı. 4.

Kolios, K., Mytilinou, V., Lozano-Minguez, E.,Salonitis, K. (2016). A Comparative Study of Multiple-Criteria Decision-Making Methods under Stochastic Inputs. MDPI Energies. 9(7).

Mani, V., Agrawal, R., Sharma, V. (2014) Supplier Selection Using Social Sustainability: AHP Based Approach in India. International Strategic Management Review. 2/2.

Sarı, F., (2018) Comparison of TOPSIS and VIKOR Multi Criteria Decision Analysis Techniques, S.Ü. Müh. Bilim ve Tekn. Derg., c.6, Özel Sayı

Sinngh, S., Dolan, J.G., Centor, R.M. (2006) Optimal Management Of Adults With Pharyngitis – A Multi-Criteria Decision Analysis. BMC Medical Informatics and Decision Makingvolume 6/14.

Uslu A., Kızıloğlu K., İşleyen S. K. ve Kahya E. (2017). "Okul yeri seçiminde coğrafi bilgi sistemine dayalı AHP-TOPSIS yaklaşımı: Ankara ili örneği", Politeknik Dergisi, 20(4): 933-943.