A HYBRID VIKOR-AHP APPLICATION ON SITE SELECTION FOR A CAFÉ RESTAURANT

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Abstract

Site selection problem is one of the topic that are studied in the literature exhaustively. In this study, a novel application of multi criteria decision making (MCDM) based on AHP and VIKOR to the selection of a place for a new café franchise presented. First, weights of each criterion are determined according to 8 expert opinions using AHP. This is followed by application of VIKOR steps assuming consensus in order to figure out the most promising place for the new franchise café shop in terms of annual rent, monthly visitors, existence of rival company and socio environment among 5 potential alternatives. The model presented is likely to be applicable for other MCDM problems.

Keywords: Multi Criteria Decision Making, Ahp, Vikor, Location Selection

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1. INTRODUCTION

Today, although cafe management is a developing sector day by day, businesses that can make correct and effective decisions in a competitive environment can make a difference to their competitors. The decisions taken at the cafe business will directly affect the success of the degree of accuracy institutions [1].

Defining the most appropriate option according to at least one objective and criteria from a set of options is called decision making problem [2].

Site selection is a complex spatial decision problem that offers many alternatives for decision makers and carries different choices [3]. Thechoice of place is quite complicated and difficult for business manager, when opening a cafe due to the increase in the cafe industry. Opening the cafe business in the wrong place will increase many problems and the costs that need to be spent to solve these problems, so there will be bad results both in terms of social needs and economic situation of the institutions [4]. Making the right decisions is an extremely important problem for the business manager to ensure the profitability of the business in today's competitive working environments.

When the literature is analyzed, it is stated that Analytical Hierarchy Process (AHP) is the most preferred method for solving many different site selection problems. In this study, the solution of the cafe sector location selection problem is handled by AHP and Vikor methods.

2. MATERIAL and METHODS

In this study, a novel application of MCDM based on AHP and VIKOR to the selection of a place for a new café franchise presented. The franchise café is CaféNero. Cafè Nero Group Ltd is a European kind of coffee house brand that founded in 1997 by Gerry Ford. Its headquarters are located in

London and it operates more than 700 coffee houses worldwide in seven countries: the UK, Ireland, Poland, Cyprus, Turkey, the UAE and the United States. Five alternative places where the café will be opened are determined according to experts' opinion and they are evaluated based on criteria such as annual rent, monthly visitors, existence of rival company and socio environment among. Criteria's weihts are to be determine through AHP based on 8 experts' opinion aggregated in a single comparison matrix with geometric mean. They are further used in a VIKOR process to determine the best location for the franchise with consensus.

2.1. Information About The Places

This section provides 5 alternative locations and their associated characteristics according to expert in the company.

2.1.1. Mersin Forum

The centre has 200 stores including kiosks, which are well known and prestigious national and international brands in Turkey. In there are6 coffee shop Starbucks, Tchibo, Caribou, KahveDünyası, GönülKahvesi, Home Store. Now here is most famous place in Mersin. Almost 1,5 million person come to here in a monthly and this makes that Forum is the best location to open a cafe in Mersin. Social media (Swarm) users has given 8.9 points.

2.1.2. Mersin Marina

Now here is another most famous place in Mersin .Almost 1 million person come to here in a monthly. Marina is very special because of position. There is a lot of big and expensive brand in here. There are 6 coffee shop in here HayalKahvesi, Lavazza, Starbucks, KahveDünyası, GönülKahvesi and Özsüt. Social media (Swarm) users has given 9,6 points.

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2.1.3. Mersin Çamlıbel Street

Çamlıbel the most colourful and valuable street which Mersin has. In here there are a lot of shopping and amusement centres. We can also say that here is old city.There are 3 coffee shop in here (Cafe Betül, Lokum and Masal). Social media (Swarm) users has given 8 points.

2.1.4. Mersin Kushimoto Street

Kushimotostreet has an interesting history and means for Mersin's people. There is a street which has same name in Japan. We can say that tithes are street of peace. Here is center of amusement with place of fun, playing centers and a lot of different restaurant there are a lot person to come here in Mersin. But there is no more interest to here after Forum and Marina. There are 2 coffee shop in here Cafe 5 Dakika and Mado). Social media (Swarm) users has given 8,7 points.

2.1.5. Mersin Viranşehir

There are 4 coffe shops in here (Gönül Kahvesi, Kahve Deposu, Kahve Evi and Sultan Kahvesi). Social media (Swarm) users has given 9,2 points for this location.
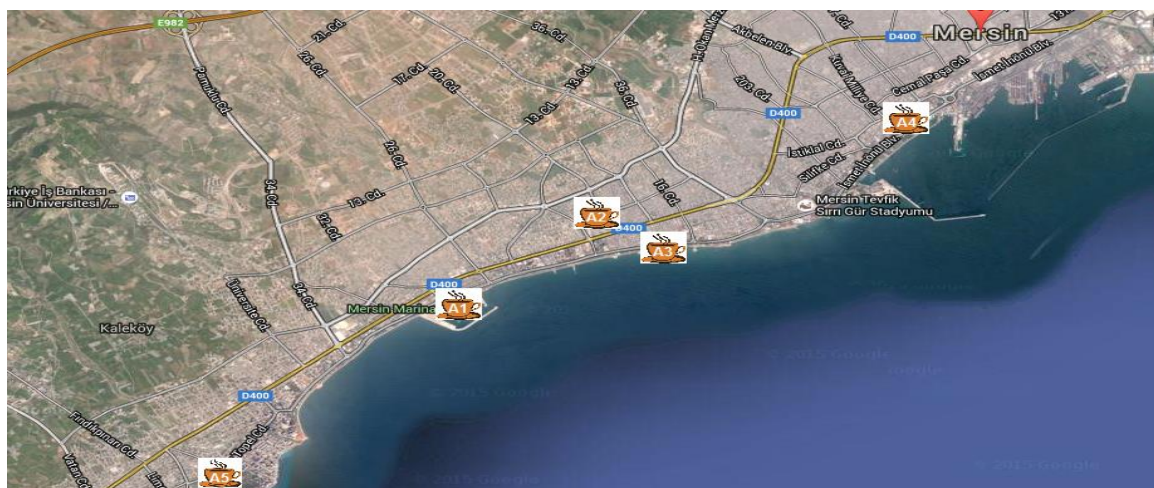
Figure 1. Alternative Places for Nero Café Franchise Branch

2.2. AHP Method (Analytic Hierarchy Proceses)

Step 1(Structure of The Hierarchy) : Building a hierarchical structure for the decision maker provide the opportunity to effectively compare criteria and alternatives [5]. The overall goal is at the top of the hierarchical structure [6]. Following the ultimate goal are the criteria for solving the problem and alternatives at the bottom of the hierarchy [7]. At this step, the decision making problem is analyzed into basic building elements and arranged into a hierarchical structure as a multi criteria decision making problem[8].

Step 2 (Binary Comparison Matrix and Relative Significance Weight Values): In this step, the relative significance weight values of the criteria are given and a binary comparison matrix is generated [9]. The binary comparison values of the criteria are based on the knowledge, experience and expertise of decision makers by judiciously exploring the decision-makers' opinions.[10]. The binary comparison matrix built for the criteria is shown with "x".

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$$x = \begin{bmatrix} w_1/w_1 & w_1/w_2 & w_1/w_3 & \cdots & w_1/w_j \\ w_2/w & w_2/w_2 & w_2/w_3 & \cdots & w_2/w_j \\ \vdots & \vdots & \vdots & & \\ w_i/w_1 & w_i/w_2 & w_i/w_3 & \cdots & w_i/w_j \end{bmatrix}$$

The values of the criteria in the binary comparison matrix are given on the basis of the scale 1-9 in Table 1 [11].

Tablo1. 1-9 Scale Used in Binary Comparison Method

Dereceler	Tanım
1	Equaly Important
3	A Bit More Important
5	Strongly Important
7	Very Strongly Important
9	Exteremly Important
2-4-6-8	Intermediate Values

tep 3 (**Eigenvector Value and Consistency Ratio) :** Equation (1) is utilized to compute the eigenvector value (w_i) of the criteria in the binary comparison matrix.

$$w_i = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_{j=1}^{n}a_{ij}} \quad (1)$$

After calculating the eigenvector value of the criteria; consistency ratio, consistency indicator and eigen values are computed. Consistency Rate; CR; shows whether the values in the comparison matrix are consistent with each other. By convention the consistency ratio should be less than 0.10 as an acceptable level of consişstency. If it is high, the comparison matrix needs to be revised and corrected so that the CR is at the acceptable level [12]. The consistency rate is compued using Equation (2).

$$CR = \frac{CI}{RI}\,(2)$$

Calculation of Consistency Index (*CI*) is achieved using Equation (3) [13].

$$CI = \frac{\lambda_{\max} - n}{n - 1}\,(3)$$

To compute the Consistency Indicator value; the maximum eigenvalue (λ_{max}) must be calculated using Equation (4) [14].

$$\lambda_{\max} = \sum_{i=1}^{n}\sum_{j=1}^{n}a_{ij}w_j\,(4)$$

The Random Index (*RI*) value (randomness indicators) in Equation (2) is shown in Table 2 [15].

Tablo 2. Randomness Indicators

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

Step 4 (Sorting Alternatives): These procedures for the criteria are applied in the evaluation of the alternatives in order to determine the best one. The alternative scores obtained are ranked from large to small and the first alternative is determined as the best alternative [16].

2.3. Vikor Method(Vise KriterijumskaOptimizacija I KompromisnoResenje)

Step 1 (Determination of Best and Worst Criteria Values) : The lines of the decision matrix ($i = 1,2,3 ..., n$) consist of criteria and these criteria are indicated by the letter "*i*", columns ($j = 1,2 , 3, ..., m$) alternate is composed of the letter "*j*". First, the best () and worst () benefit criterion values are calculated. If the criterion has the benefit feature, it is calculated with Equation (5).

$$f_j^* = \max f_{ij}$$
$$f_j^- = \min f_{ij}$$
$$(5)$$

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If the i. criterion has a cost feature, it is calculated by Equation (6):

$$f_j^* = \min f_{ij}$$
$$f_j^- = \max f_{ij}$$
(6)

Step 2 (Calculation of Average Group and Worst Group Score) : S_j for each alternative ($j = 1,2,3, ..., m$) in the decision matrix (average group score for alternative j) Equation (7) and R_j (worst group score for alternative j) Equation (8) is calculated. This step refers to the criteria weights.

$$S_j = \sum_{i=1}^{n} w_i \left(f_i^* - f_{ij} \right) / \left(f_i^* - f_i^- \right) \quad (7)$$

$$R_j = \max_i \left[w_i \left(f_i^* - f_{ij} \right) / \left(f_i^* - f_i^- \right) \right] \quad (8)$$

Step 3 (Calculation of Maximum Group Benefit) : Q_j (maximum group benefit) for each alternative ($j = 1,2,3, ..., m$) is calculated by Equation (9).

$$Q_j = v \left(S_j - S^* \right) / \left(S^- - S^* \right) + (1-v) \left(R_j - R^* \right) / \left(R^- - R^* \right) \quad (9)$$

In this equation; S^* minimum S_j value; S^- maximum S_j value; R^* is the minimum R_j value and R^* is the maximum R_j value. "v value" refers to the maximum group benefit weight and "$(1-v)$" indicates the weight of the minimum regret of the opponents.

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Step 4 (Ranking of Average Group, Worst Group Score and Maximum Group Benefit Values) : In this step, S_j, R_j and Q_j values obtained for each alternative are sorted from small to large and three independent ranking lists are obtained.

Step 5 (Checking Conditions): The first alternative in the ranking list of Q_j value in the previous step is determined as A^1 and the second alternative is A^2. Acceptable advantage (K1) and acceptable stability (K2) conditions are required to determine the alternative with the best Q (minimum) value. Equations (10) and (11) are used to provide the K1 condition.

$$Q\left(A^2 \right) - Q\left(A^1 \right) \geq DQ$$
(10)

$$DQ = 1 / \left(J - 1 \right)$$
(11)

It shows the number of all alternatives with "J". The more the difference between A^1 and A^2, the more useful it will be to choose the best alternative. In order to ensure the K2 condition; S_j, R_j and Q_j values of all alternatives are examined. If the value of any alternative S_j, R_j and Q_j are in the same order in all of the tables, this condition is considered to be realized. If any of these conditions does not occur, the alternative with the minimum value of Q_j is chosen as the best alternative.

3. APPLICATION

In order to determine a place for new branch for CaffèNero shop in Mersinamong available five alternative located to take franchise, Mersin Marina, Forum Mersin Avm, Kushimoto Street, Çamlıbel, Viranşehir first of all four criteria were determined. These are: annual rent (C1), monthly visitors (C2),

rival company (C3)and social environment (C4). The novel application of multi-criteria decision making for the problem is described in Figure 2.
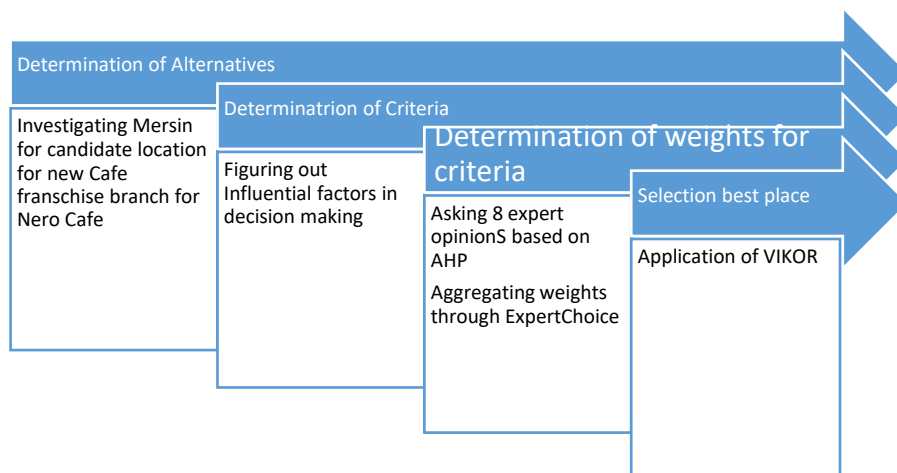
Figure 2. Research Structure for Hybrid Application of AHP and VIKOR

In order to determine overall weights of these criteria, owner of eight cafees in Mersin: MasalButik, Lokum, Café 5 dk, Özsüt, KahveBeyi, Starbucks, Mado, GönülKahvesi were asked to conduct pairwise comparisons in AHP methodology of which they are aggregated to determine final weights of each criterion. These 8 pairwise evaluation of criteria were displayed in Table 3.

Table 3. Pairwise Comparison of Criteria by 8 Café Shops' Owners

MasalButik	Cr1	Cr2	Cr3	Cr4	Lokum	Cr1	Cr2	Cr3	Cr4
Cr1	1	5	5	1/7	C1	1	1/7	1/5	1/9
Cr2		1	9	9	C2		1	8	1/8
Cr3			1	1/7	C3			1	1/9
Cr4				1	C4				1
Café 5 dk	Cr1	Cr2	Cr3	Cr4	Özsüt	Cr1	Cr2	Cr3	Cr4
Cr1	1	1/9	7	8	C1	1	1/9	7	1/9
Cr2		1	7	9	C2		1	9	8
Cr3			1	1/7	C3			1	1/9
Cr4				1	C4				1
KahveBeyi	Cr1	Cr2	Cr3	Cr4	Starbucks	Cr1	Cr2	Cr3	Cr4
Cr1	1	1/3	5	4	C1	1	1/9	9	1/7
Cr2		1	9	7	C2		1	8	1/9
Cr3			1	5	C3			1	1/9
Cr4				1	C4				1
Mado	Cr1	Cr2	Cr3	Cr4	GönülKahvesi	Cr1	Cr2	Cr3	Cr4
Cr1	1	1/9	9	1/7	C1	1	1/3	5	1/3
Cr2		1	8	1/9	C2		1	1/3	1
Cr3			1	1/9	C3			1	5
Cr4				1	C4				1

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Overall aggregated weights based on these 8 pairwise comparison matrix are displayed in Table 4.

Table 4. Criteria and weights in the evaluation

	Criteria	Weights
Cr1	Annual Rent	0,158
Cr2	Monthly visitors	0,504
Cr3	Rival Company	0,078
Cr4	Socio Environment	0,260

Based on available information, the data to be used for VIKOR was organized for each alternatives according to each criterion as in Table 5. Table 4 reflects that for a coffee shop the most dominant criteria for the site selection is 'monthly visitors' as intuitively expected. It directly affects the popularity and profitability of the enterprise.

Following the AHP, another multi criteria decision technique, namely VIKOR, to be applied as a search the consensus among the criteria whose weights are determined by the AHP explicitly taking into account decision maker's opinion. The performances of each of 5 alternative places (Marina, Forum, Kushimato, Çamlıbel, and Viranşehir) on each of 4 criteria (annual rent, monthly visitors, rival company socio environment) are tabulated and displayed in Table 5.

Table 5. Data of Alternatives for VIKOR

Alternative	Critera			
	Cr1(TL)	Cr2	Cr3	Cr4
Marina	285.000,00	0,8	6	9,6
Forum	207.200,00	1,5	6	8,9
Kushimato	60.000,00	0,5	2	8,7
Çamlıbel	40.000,00	0,2	3	8,3
Viranşehir	55.000,00	1	4	9,2

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Using the data presented in Table 5, the best (f_i^*) and the worst (f_i^-) values for each criterion were determined and displayed in Table 6.

Table 6. (f_i^*) and (f_i^-) values for all criteria.

	Criteria	f_i^*	f_i^-
Cr1	Annual Rent	40.000,00 TL	285.000,00 TL
Cr2	Monthly visitors	1,5	0,2
Cr3	Rival Company	2	6
Cr4	Social Environment	9,6	8,3

According to Step 2 and Step 3 of Vikor method, S_j, R_j and Q_j values for each alternative were computed and tabulated in Table 7.

Table 6. S_j, R_j, Q_j values and ranking results.

	S_j	R_j	Q_j
A1	0,507384	0,271385	0,538641
A2	0,325826	0,14	0,06408
A3	0,58059	0,387692	0,840237
A4	0,7835	0,50400	1,393128
A5	0,32251	0,193846	0,073964

After 5 alternatives for the best (f_i^*) and the worst (f_i^-) were determined for every criterion for S_j, R_j $(j = 1, 2, 3, 4, 5)$ can be determined using (3) and (4). After that this equation Q_j $(j = 1, 2, 3, 4, 5)$ was designated using by (5). Assuming v=0,5 and sorting S, R and Q in ascending order for Caffé Nero, two list of optimal choice processing was obtained as in Table 7.

Table 7. S_j, R_j, Q_j values and ranking results.

	S_j		R_j		Q_j
A5	0,32251	A2	0,14	A2	0,06408
A2	0,325826	A5	0,193846	A5	0,073964
A1	0,507384	A1	0,271385	A1	0,538641
A3	0, 58059	A3	0,387692	A3	0,840237
A4	0,7835	A4	0,50400	A4	1,393128

According to Vikor application whose steps were demonstrated above, the most suitable place for the new Nero Café franchise branch is found to be Mersin Forum (A2) followed by Viranşehir(A5) and Marina (A1), which are 3 places that are close to each other.

4. CONCLUSION

In this study, a new model based on hybrid application of AHP and Topsis was developed and applied in order to help to managers decide the most proper cafe side selection for Nero Café. The weights of the selection criteria were determined by the AHP's 8 pairwise comparison matrix of owners of competitive brands of Café, and aggregated them through expert choice. Later VIKOR method with weights obtained through AHP was used as one of the multi-criteria decision-making methods for the ranking of the alternatives. In conclusion, it has produced three separate results for the alternative cafes places. According to criteria set, it was found that the best coffee place in Mersin is Forum AVM. In turn, the other top two cafes where is Marina and Kushimoto.

The hybrid application of AHP and Vikor appears to be promising to be applied to similar decision making problems, contributing to the literature in multi-criteria decision making. The approach employed in this study is based on group evaluation of alternatives with AHP for the criteria of MCDM problem, and then followed by a VIKOR forming a hybrid application of MCDM techniques. This hybrid approach can be applied into similar decision making environment filling the gap in associated literature. With this approach the power of AHP in reflecting the decision maker's opinions explicitly about criteria of the problem in consideration and the power of VIKOR that seeks the consensus around the criteria is to be combined in an attempt to figure out the best alternative in a multi criteria decision making context.

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