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Determination of the Most Appropriate Housing Loan Provider with the MABAC Method Considering Environmental, Social and Economic Criteria

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Abstract: The banking sector in Turkey is one of the most important industries with its asset size, and loans are the largest item in the sector. Due to global legal regulations and increasing competition, banks have to consider environmental and social factors as well as economic factors in order to maintain their current position. Therefore, in this study, a Multi-Criteria Decision Making (MCDM) problem has been put forward for the evaluation of housing loans provided by banks by considering environmental and social criteria as well as economic aspects. A Multi-Attributive Border Approximation Area Comparison (MABAC) method was used in the integrated evaluation of 7 banks located in Turkey with the criteria obtained from the literature. In the ranking obtained, Ziraat Bank took the first place, İş Bank took the second place and Vakıf Bank took the third place.

Çevresel, Sosyal ve Ekonomik Kriterler Dikkate Alınarak MABAC Yöntemi ile En Uygun Konut Kredisi Sağlayıcının Belirlenmesi

Anahtar Kelimeler
Konut Kredisi,
Banka,
Sürdürülebilirlik,
ÇKKV,
MABAC,

Öz: Türkiye'de bankacılık sektörü, aktif büyüklüğü ile en önemli sektörlerden biri olup sektörün en büyük aktif kalemi olan kredilerdir. Küresel yasal düzenlemeler ve artan rekabet nedeniyle bankalar mevcut konumlarını koruyabilmek için ekonomi faktörlerin yanı sıra çevresel ve sosyal faktörleri de göz önünde bulundurma zorundadırlar. Bu nedenle bu çalışmada, bankalar tarafından sağlanan konu kredisinin ekonomik değerlendirmesinin yanı sıra çevresel ve sosyal kriterleri de dikkate alınarak değerlendirilmesi için bir Çok Kriterli Karar Verme (ÇKKV) problemi ortaya konulmuştur. Literatürde elde edilen kriterlerle Türkiye'de yerleşik 7 bankanın bütünleşik değerlendirmesinde Çok Nitelikli Sınır Yakınlaştırma Alanı Karşılaştırması (MABAC) metodu kullanılmıştır. Elde edilen sıralama da Ziraat Bankası birinci, İş Bankası ikinci ve Vakıfbank üçüncü sırada yer almıştır.

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1. Introduction

The banking sector in Turkey was one of the most important sectors with an asset size of ₺12,699,119 in August 2022 [1]. Loans, which were the largest asset item in August 2022, amounted to ₺6,661,162. The sector's total assets increased by 37.8% in 2021, while its total loans increased by 35.5%. Asset sizes and growth rates clearly reveal the size of the banking sector. For this reason, banks have a decisive mission with their services in all kinds of issues such as the environment and social justice. Because everyone, between the public and private sectors, from the states to individuals, needs banks. However, due to increasing competition and various legal regulations, banks have to consider environmental factors as well as economic factors in order to maintain their current positions [2]. Today, the protection and improvement of the environment have gained importance in the banking sector as it is an important issue that every sector focuses on. Many banks have started to publish reports as well

as their environmental and social impacts besides their economic activities. One of the most important problems in this sector is the greenhouse gas reporting rate with methods such as CDP (Carbon Disclosure Project).

One of the sectors where competition is most intense, banks' efforts in the field of environmental impacts have now become important for consumers as well. When it concerns loans, which are the most valuable asset for banks, consumers are typically cost-conscious. As in other industries, environmentally concerned consumers are on the verge of favoring banks that consider their environmental impact when determining their bank loan choices. Because it is not possible to ignore the environmental impacts of banks with significant economic size.

In the literature, the studies on the bank selection of the customers were primarily in the form of determining the selection criteria. For instance, Alferos and Cristobal [3] discovered that the Philippines' savings rate, convenient location, and overall quality of service were the most crucial factors when choosing a bank, followed by the availability of self-banking facilities, fees for bank services, and low interest rates on loans. According to Ta and Har's [4] research, Singaporeans choose their banks based on the caliber of their services, staff recommendations, and supplementary services. Dhinaiyagovind [5] looked at the factors influencing bank preference and selection criteria in India and discovered that a bank's reputation was the most crucial factor. Shammami and Mili [6] found that loan and deposit interest rates and transaction costs were the main factors used to attract customers in the selection of banks. Utilizing earlier research from the literature and expert input, Akpınar [7] created the bank selection criteria for Turkish consumers. Ten determined bank selection criteria were feeling special, low service fees, financial advice, confidentiality, speed, variety of services, easy credit, easy access, ease of use, total service quality. On the other hand, Koçak and Çalık [8] employed six variables to evaluate five banks in their model, including the number of ATMs, fees and commissions, guidance, and employee characteristics. Environmental and relatively social criteria have been ignored in most of these studies, which evaluate banks by determining bank selection criteria.

There has been an increasing interest in the literature recently for the evaluation of branches in terms of sustainability. Khan et al. [9], and Sobhani et al. [10] for Bangladeshi banks; Roca and Searcy [11] for Canadian banks; Kumar et al. [12] for the Indian banking sector; Weber [13] for Chinese banks; Nobanee and Fifties [14] for United Arab Emirates banks, and Aras et al. [15] for Turkish banks carried out corporate sustainability analyzes with various methods. Financial and non-financial reports, websites and sustainability reports were generally taken into account in these analyzes. However, none of these studies performed analysis at the level of a banking product.

The application of MCDM problems to bank selection was available in the literature and was very limited. For example, Javalgi et al. [16] studied bank selection in the USA using Analytical Hierarchy Process (AHP). Arslan [17] used Simple Multi-Attribute Rating Technique (SMART) and Evaluation based on Distance from Average Solution (EDAS) methods to select the most suitable bank for a loan in Turkey. As a result of the analysis, Ziraat Bank ranked first. Koçak and Çalık [8] used the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) technique to rank different banks, whereas they employed AHP in both the classical logic and fuzzy logic environments to study the factors influencing consumer choice in the bank selection process. Eş and Kamacı [18] analyzed the banks operating in Turkey using EDAS and A new additive ratio assessment (ARAS) methods, and the sustainability performances of the banks were listed. Chien et al. [19] employed Fuzzy Analytical Network Process (FANP) and TOPSIS methods to select the best leasing company. Akpınar [7] used TOPSIS and Elimination and Choice Translating Reality (ELECTRE) methods to determine the bank selection criteria of consumers in Turkey. Shammami and Mili [6] applied a fuzzy analytical hierarchy process (FAHP) multi-criteria decision model, ranking customers' priorities in the selection of commercial banks. The methods generally used in bank selection problems were limited to AHP, EDAS, ARAS, ELECTRE and TOPSIS.

In the literature, the number of studies measuring corporate sustainability performance using MCDM methods was quite limited. Özçelik and Avcı Öztürk [20] measured the sustainability performance of banks using the gray relational analysis (GIA) method, using sustainability reports. The banks with the best performance were TSKB, Garanti Bank and Akbank. Goyal et al. [21] evaluated corporate sustainability practices using the AHP method. The investigation' findings showed that the most crucial practices for enhancing a company's performance in terms of sustainability were those related to market value, environmental management and strategy, development and research pollution prevention, corporate management, and investor responsibility. Aras et al. [22] and Ömürbek et al. [23], on the other hand, evaluated the sustainable performance of various branches in Turkey with the entropy-based TOPSIS and ARAS, multi objective optimization on the basis of simple ratio analysis (MOOSRA) and Complex Proportional Assessment (COPRAS) methods, respectively. Rebai et al. [24] evaluated three French banks with the AHP method and Korzeb and Samaniego-Medina [25] evaluated the banks in Poland with the TOPSIS method and revealed their sustainability performance.

As a result of the literature review, in most of the bank selection studies, the criteria that include the environmental and social dimensions of sustainability were used very limitedly, while the studies evaluating these dimensions generally focus on the measurement of the sustainability performance of the banks and do not make an evaluation on the basis of credit products in terms of conscious consumers, and generally limited MCDM methods were used in bank selection problems. It has been determined that no one uses the MABAC method. The MABAC technique, a straightforward and logical approach to problem-solving, was chosen because the resulting findings are stable and account for the hidden values of gains and losses [26], [27]. Moreover, it has been found that the measurement of sustainability performance needs more work, especially in the field of financial services [15], [28]. This study proposed to fill these gaps in the literature by evaluating banks by using the MABAC method by including social and environmental criteria as well as economic criteria for housing loan preference by conscious customers.

Housing loan selection, which is conducted by considering many different environmental, social, and economic criteria, is a MCDM problem for consumers. For this reason, in this study, an MCDM problem has been put forward for evaluating the housing loan provided by the banks in Turkey by considering their environmental and social impacts in addition to their economic impacts. Using the MABAC MCDM approach, a rating of the banks offering housing loans was given. This research is structured as follows; the second section was devoted to materials and methods. In the first part of the second section, the MABAC method was introduced, and in the second part, the problem was defined and the MABAC method was applied. The results and conclusion were presented in the study's final section.

2. Material and Method

The aim of this study was to rank the alternatives for housing loan use from banks residing in Turkey by MABAC method, considering environmental and social criteria as well as economic criteria. In the next parts of the study, after the definitions of the MABAC method were made, the application phase of the problem was started.

2.1. MABAC method

Although the MABAC method, developed by Pamučar and Ćirović [29] in 2015, was a new approach, it has been very popular in the literature. Examples of these were material, enterprise resource planning, personnel selection and analysis of satisfaction level [30]–[33] . The MABAC Steps are given below;

Step 1: Creation initial decision matrix (X). In this step, the evaluation of *m* alternatives by *n* criteria are conducted. The alternatives are presented with the vectors $A_i(= X_{i1}, X_{i2}, ,...,)$ where X_{ij} is the value of the *i* alternative by *j* criterion (i =1, 2,...,m; J= 1, 2,...,n) where *m* is the alternative number, *n* is total number of criteria. The criteria are presented with the vectors C_n.

$$X = \begin{array}{c} \\ A_1 \\ A_2 \\ \dots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{11} & x_{22} & & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{1m} & x_{2m} & \dots & x_{mn} \end{bmatrix} \end{array} \quad (1)$$

Step 2: Normalization of initial decision matrix (X) elements.

$$N = \begin{array}{c} \\ A_1 \\ A_2 \\ \dots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} t_{11} & t_{12} & \dots & t_{1n} \\ t_{11} & t_{22} & & t_{2n} \\ \dots & \dots & \dots & \dots \\ t_{1m} & t_{2m} & \dots & t_{mn} \end{bmatrix} \end{array} \quad (2)$$

Elements of normalized matrix *(N)* are obtained by applying the expression:

a) For benefit-type criteria

$$t_{ij} = \frac{x_{ij} - x_i^-}{x_i^+ - x_i^-} \tag{3}$$

b) For cost-type criteria

$$t_{ij} = \frac{x_{ij} - x_i^+}{x_i^- - x_i^+} \tag{4}$$

where X_{ij}, X_i^+ and X_i^- present the elements of initial decision matrix *(X)*, where in X_i^+ and X_i^- are defined as follows:

$X_i^+ = \max (x_1, x_2, \ldots x_m)$ represents maximum values of the observed criterion by alternatives.

$X_i^- = \min (x_1, x_2, \ldots x_m)$ represents minimal values of the observed criterion by alternatives

Step 3: Calculation of weighted matrix (V) elements.

$$V = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} \tag{5}$$

Weighted matrix (V) elements are calculated based on the expression (6):

$$V_{ij} = w_i * t_{ij} + w_i \tag{6}$$

where t_{ij} presents the elements of normalized matrix (N), w_i presents weight coefficients of criteria.

Step 4: Determination of border approximate area matrix (G). The border approximate area for every criterion is defined according to the expression (7)

$$g_i = \left(\prod_{j=1}^{m} v_{ij} \right)^{1/m} \tag{7}$$

where v_{ij} presents weighted matrix elements (V), m presents total alternatives number.

Step 5: Calculation of matrix elements of alternative distance from the border approximate area (Q)

$$Q = \begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ q_{21} & q_{22} & & q_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ q_{m1} & q_{m2} & \cdots & q_{mn} \end{bmatrix} \tag{8}$$

The alternative distance from the approximate border area (q_{ij}) is determined as the difference of weighted matrix elements (V) and the values of border approximate area (G);

$$Q = V - G \tag{9}$$

Step 6: Locations are determined according to the border proximity area. The alternative A_i can belong to the border approximate area (G), upper approximate area (G^+) or lower approximate area (G^-). Belonging of the alternative A_i to the approximate area is determined based on the expression (10).

$$A_i \in \begin{cases} G^+ \ if \ q_{ij} > 0 \\ G \ \ if \ q_{ij} = 0 \\ G^- \ if \ q_{ij} < 0 \end{cases} \tag{10}$$

Step 6. Ranking alternatives. The total of the alternative's (11) distances from the approximate area (q_i) area is used to calculate the values of criteria functions by alternatives. The final values of the criteria function of alternatives are calculated by summing the matrix elements Q along the lines.

$$S_i = \sum_{j=1}^{n} q_{ij}, \ j = 1,2,...,n, \ \ i = 1,2,...,m \tag{11}$$

where n presents the number of criteria, m presents the number of alternatives.

2.2. Problem statement

In order to evaluate the housing loan provided by banks in Turkey for conscious consumers in terms of environmental, economic and social dimension, criteria and weights were determined at the first stage. In the second stage, the banks were ranked by evaluating the alternatives in the problem with the MABAC method.

Criteria selection

The most important step of social, economic and environmental evaluation is to determine the criteria correctly. For this reason, the criteria to be used in this study were carried out by reviewing the literature. The criteria and details are given in Table 1. Information about the criteria was obtained from the banks' websites and sustainability reports. For the criteria selected for the evaluation, 21 banks residing in Turkey and providing housing loans were examined, and finally, 7 banks whose data were available for all criteria were included in the evaluation.

Table 1. Criteria List

Criteria	Name	Unit	Max/Min	Weight	Reference
C1	Capital adequacy ratio	%	Max	0.14	[20]
C2	Total branches	Number	Max	0.1	[34]
C3	Total employees	Number	Max	0.1	[34]
C4	Total ATM	Number	Max	0.2	[35]
C5	Scope 1 Emissions	TCO2e	Min	0.11	[20]
C6	Scope 2 Emissions	TCO2e	Min	0.11	[20]
C7	Interest rate	%	Min	0.2	[36]
C8	Credit allocation file cost	TL	Min	0.012	[17]
C9	Appraisal fee	TL	Min	0.018	[37]
C10	Housing facility fee	TL	Min	0.01	[37]

The MABAC implementation

The solution of the problem with the MABAC method is given below step by step.

Step 1: Creation initial decision matrix (X) were created and given in Table 2. Maximum and minimum values of criteria in the initial decision matrix were calculated and given in Table 3.

Table 2. Initial Decision Matrix (X)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10

Am	Max	Max	Max	Max	Min	Min	Min	Min	Min	Min
A1	14.0	841	18354	5306	18643	0	29.69%	5000	1450	250
A2	16.5	1730	24607	7264	34198	38564	15.58%	5000	1092	365
A3	21.1	710	12184	5202	18187	24300	26.28%	5000	1070	207
A4	14.5	1030	20339	4059	15795	31406	14.40%	5000	1100	390
A5	20.4	1118	22802	6555	22528	8784	23.40%	5000	1890	405
A6	14.7	940	16928	4222	12796	5406	15.48%	10000	1500	0
A7	16.3	801	15452	4526	15717	25450	25.32%	5000	1351	405

Table 3. Maximum and Minimum Values of Criteria in the Initial Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
X_j+	21.1	1730	24607	7264	34198	38564	0.296	10000	1890	405
X_j-	13.9	710	12184	4059	12796	0	0.144	5000	1070	0

Step 2: Normalization of initial decision matrix (X) elements were calculated and given in Table 4.

Table 4. Normalized Initial Decision Matrix

Am	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	0	0.128	0.497	0.389	0.727	1	0	1	0.537	0.383
A2	0.354	1	1	1	0	0	0.923	1	0.973	0.099
A3	1	0	0	0.357	0.748	0.370	0.223	1	1	0.489
A4	0.069	0.314	0.656	0	0.860	0.186	1	1	0.963	0.037
A5	0.902	0.400	0.855	0.779	0.545	0.772	0.411	1	0	0
A6	0.104	0.225	0.382	0.051	1	0.860	0.929	0	0.476	1
A7	0.326	0.089	0.263	0.146	0.864	0.340	0.286	1	0.657	0

Step 3: Weighted matrix (V) elements were calculated and given in Table 5.

Table 5. Weighted Decision Matrix

Am	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	0.140	0.113	0.150	0.278	0.190	0.220	0.200	0.024	0.028	0.014
A2	0.190	0.200	0.200	0.400	0.110	0.110	0.385	0.024	0.036	0.011
A3	0.280	0.100	0.100	0.271	0.192	0.151	0.245	0.024	0.036	0.015
A4	0.150	0.131	0.166	0.200	0.205	0.130	0.400	0.024	0.035	0.010
A5	0.266	0.140	0.185	0.356	0.170	0.195	0.282	0.024	0.018	0.010
A6	0.154	0.123	0.138	0.210	0.220	0.205	0.386	0.012	0.027	0.020
A7	0.186	0.109	0.126	0.229	0.205	0.147	0.257	0.024	0.030	0.010

Step 4: Border approximate area matrix (G) were determined and given in Table 6.

Table 6. Boundary Proximity Matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
g_j	0.189	0.128	0.149	0.270	0.181	0.161	0.298	0.022	0.029	0.012

Step 5: Matrix elements of alternative distance from the border approximate area (Q) were calculated and given in Table 7.

Table 7. Distances of Alternatives from the Boundary Proximity Area

Am	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	-0.049	-0.015	0.001	0.008	0.009	0.059	-0.098	0.002	-0.001	0.001
A2	0.001	0.072	0.051	0.130	-0.071	-0.051	0.086	0.002	0.006	-0.001
A3	0.091	-0.028	-0.049	0.002	0.012	-0.010	-0.054	0.002	0.007	0.002
A4	-0.039	0.004	0.017	-0.070	0.024	-0.031	0.102	0.002	0.006	-0.002
A5	0.078	0.012	0.037	0.086	-0.011	0.034	-0.016	0.002	-0.011	-0.002
A6	-0.034	-0.005	-0.010	-0.059	0.039	0.044	0.087	-0.010	-0.003	0.008
A7	-0.003	-0.019	-0.022	-0.040	0.024	-0.014	-0.041	0.002	0.001	-0.002

Step 6: Locations were determined according to the border proximity area and alternatives were ranked. The Ranked bank and their Si are given in Table 8.

Table 8. Alternative Ranking

Rank	Bank	A_m	S_i
1	Ziraat Bank	A2	0.227
2	İş Bank	A5	0.209
3	Vakıflar Bank	A6	0.056
4	Halk Bank	A4	0.013
5	Akbank	A3	-0.024
6	Garanti Bank	A1	-0.082
7	Yapı Kredi Bank	A7	-0.115

3. Results and Conclusion

According to the results, it was determined that the bank preference that best meets the determined criteria of the consumers should be in favor of Ziraat Bank. The comparison of the S_i values is given in Figure 1. The last preferred bank was Yapı Kredi Bank. Ziraat Bank was the bank with the best ranking according to environmental, social and economic criteria with a S_i value of 0.227. İş Bank followed this bank with a S_i value of 0.207. The values of these two banks were calculated very close to each other. The S_i value of Vakıf Bank, which was the third bank in the ranking with 0.056 S_i value, which was quite far from the value of the first two banks. Finally, the S_i value of Halk Bank, the fourth bank, was calculated as 0.013. The S_i values of Akbank, Garanti and Yapı Kredi Banks were calculated as negative. Akbank had a S_i value of -0.024 and Garanti Bank had a S_i value of -0.082. Lastly, Yapı Kredi Bank had a S_i value of -0.115. With these values, Yapı Kredi Bank was the bank with the worst ranking.

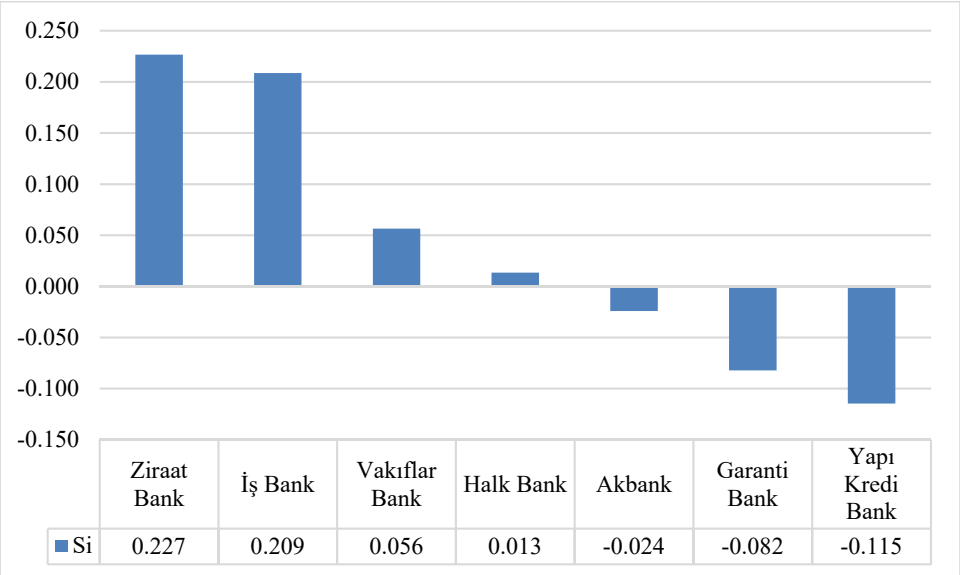

Figure 1. Ranking of Alternatives

The banks with the highest Capital adequacy ratio, total branches, employees, and ATMs were Ziraat Bank and İş Bank. Since it was desirable that these requirements be maximal, the contribution of these data to the achieved findings was substantial. However, despite being the bank with the greatest scope 1 and scope 2 emissions, Ziraat Bank placed top due to its low interest rate, low appraisals fees, and low housing facility fees. Despite having a moderate interest rate compared to other banks, İş Bank scored second due to its scope 2 emissions and low appraisal and housing facility fees. Vakif Bank, on the other hand, was placed third since it was the bank with the lowest scope 1 emissions and the second-lowest interest rate, despite the fact that other criteria values were of a moderate nature. Halk Bank was the fourth-ranked bank with the lowest interest rate and the third-highest number of employees. Although Akbank had the lowest total branch value, it ranked fifth because it had the lowest appraisal and housing facility fees. The sixth-ranked Garanti Bank had the lowest scope 2 emissions, but its interest rate was high and its capital adequacy ratio was inadequate. The bank in last order, Yap Kredi, had one of the three highest interest rates, but all other criteria values were average.

Ziraat Bank ranked first in a study conducted by Arslan [17] to determine which of four Turkish banks offers the most suitable loan with SMART and EDAS methods. This result was identical to the findings of this study. However, Garanti Bank ranked second in the evaluation based solely on economic criteria, but seventh in this study that also considers environmental and social criteria. Akbank ranked third in Arslan's [17] study and fifth in this study. Although İş Bank, the final bank evaluated, was ranked fourth, it was ranked second in this research. These results demonstrated that decision makers can make different choices if additional dimensions, such as environmental assessment criteria, are considered.

The aim of this study was to evaluate the housing loans provided by the banks operating in Turkey based on the economic, social and environmental criteria. The MABAC method, which has not been used in this field before, was chosen as the evaluation method. According to the results, in the integrated evaluation of the 7 banks examined, Ziraat Bank ranked first, İş Bank was ranked second, and Vakıf Bank ranked third. These results revealed that only the economic point of view cannot be sustained in the evaluation of bank products and that environmental and social criteria are important. The findings of this study provided scientists, policy makers and industry experts with a perspective on the criteria that are important in consumer preference for banking products. In addition, with the increasing importance given to environmental and economic impacts, it indirectly contributed to the development of this field. In future studies, this study can be expanded by expanding the selected criteria and applying other MCDM methods.

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