Financial Performance Analysis of BIST Energy Index Companies with LOPCOW-CRITIC Based CoCoSo Methods

BIST Enerji Endeksi Şirketlerinin LOPCOW-CRITIC Tabanlı CoCoSo Yöntemleri ile Finansal Performans Analizi

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ABSTRACT

The aim of this study is to investigate the financial performance of energy companies traded in Borsa Istanbul (BIST) for the period 2022 using hybrid MCDM methods. In this paper, a new model based on LOPCOW-CRITIC and CoCoSo is proposed to examine the financial performance of selected companies. The criteria were determined based on previous research in this field. A financial performance analysis was conducted considering thirteen criteria and twenty-two companies. Two objective weighting methods, namely LOPCOW and CRITIC, were used to calculate the weights of the criteria. Afterwards, the criterion weights were combined using the aggregate weighting method (AWM). According to results obtained from the AWM method, inventory turnover rate and asset turnover rate were found to be the most and least important criteria, respectively. Once the weights of the criteria were determined, the alternatives were ranked using the CoCoSo method. According to results gathered from the CoCoSo method, it was observed that MAGEN and PAMEL had the highest and lowest financial performance, respectively. Moreover, the proposed model was tested using a sensitivity analysis. The robustness and reliability of the proposed model were monitored under ten different scenarios. Overall results emphasized that MAGEN, ZEDUR, and KARYE had the highest financial performance, while ARASE, AKSEN, and PAMEL had the lowest financial performance in 2022, respectively.

KEYWORDS

Financial Performance; BIST100; Energy Companies; MCDM

ÖZ

Çalışmanın amacı, Borsa İstanbul'da (BIST) işlem gören enerji şirketlerinin 2022 dönemi finansal performansının hibrit ÇKKV yöntemleri kullanılarak araştırılmasıdır. Bu çalışmada, seçilen şirketlerin finansal performansını incelemek için LOPCOW-CRITIC ve CoCoSo'ya dayalı yeni bir model önerilmektedir. Kriterler bu alanda daha önce yapılan araştırmalara dayanarak belirlenmiştir. Finansal performans değerlendirmesi, on üç kriter ve yirmi iki şirket dikkate alınarak gerçekleştirilmiştir. Kriterlerin ağırlıklarının hesaplanmasında LOPCOW ve CRITIC olmak üzere iki farklı objektif ağırlıklandırma yöntemi kullanılmıştır. Daha sonra kriter ağırlıkları toplu ağırlıklandırma yöntemi (AWM) kullanılarak birleştirilmiştir. AWM yönteminden elde edilen sonuçlara göre stok devir hızı ve ATR sırasıyla en önemli ve en az önemli kriter olarak bulunmuştur. Kriterlerin ağırlıkları belirlendikten sonra alternatifler CoCoSo yöntemi kullanılarak sıralanmıştır. CoCoSo yönteminden elde edilen sonuçlara göre MAGEN ve PAMEL'in sırasıyla en yüksek ve en düşük finansal performansa sahip olduğu tespit edilmiştir. Ayrıca önerilen model duyarlılık analizi kullanılarak test edilmiştir. Önerilen modelin sağlamlığı ve güvenilirliği on farklı senaryo altında izlenmiştir. Genel sonuçlar, 2022 yılında MAGEN, ZEDUR ve KARYE'nin en yüksek finansal performansa sahip olduğunu, en düşük finansal performansı ise sırasıyla ARASE, AKSEN ve PAMEL'in gösterdiğini ortaya koymuştur.

ANAHTAR KELİMELER

Finansal performans, BIST100, Enerji işletmeleri, ÇKKV

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INTRODUCTION

Natural energy, which has played a significant role in the development of countries since the Industrial Revolution, still maintains its importance today. However, natural energy sources are gradually decreasing in the face of the increasing world population. Therefore, innovations aimed at increasing energy sources are becoming more prominent in the energy sector. It is important for energy companies to be economically strong and have high financial performance for the country's economy and development (Sönmez, Baysal, Baysal and Bademcioğlu, 2022). Electricity, the secondary energy source, has responded to the needs of an increasing population and industrialization with its easy use and rapidly increasing popularity (Topal, 2021). Additionally, as a result of the acceleration of the digitalization process, the world's electricity demand has increased by twofold. Turkey's total electricity consumption reached 327 TWh at the end of 2021, with a yearly growth rate of 9%. While industry has a 44% share of electricity consumption, residences and commercial establishments have an equal share of 24%. Lighting and agricultural irrigation account for 2% and 5% of consumption, respectively (KPMG- 2022). The high level of energy consumption makes companies operating in this sector increasingly important.

Performance can be defined as measurable and evaluable criterion, shows how successful companies are in achieving their goals (Martin, 1997, p. 435). Performance evaluation can be done for each department of a company, but the most important aspect is the measurement and accurate evaluation of financial performance. The use of financial reports in financial performance measurement increases the reliability of performance evaluation (Bağcı and Yüksel Yiğiter, 2019, p. 878). Additionally, performance measurement is directly related to the outputs of the company. This situation is important in terms of comparing the company's performance with past periods and competitor companies in the sector (Cooper, 2004: 43). In order to determine the ability of companies to achieve their goals, various financial performance measurement methods are used. However, when using these methods, certain criteria should be taken into consideration, and calculations should be made. In this context, multi-criteria decision-making methods (MCDM) are widely used to performance evaluation (Dursun, 2018; Ertaş and Yetim, 2022; Özekenci, 2023a, 2023b, Özbek and Özekenci, 2023). In this study, financial ratios representing the relationship between two items in financial statements, such as liquidity, turnover, capital structure, and profitability ratios.

For this investigation, the criteria were determined by the literature review. Previous research reported that various ratio such as, current ratio, liquidity ratio, cash ratio, receivable turnover rate, asset turnover rate, equity turnover rate, inventory turnover rate, leverage ratio, ratio of short-term debt to total liabilities, ratio of long-term debt to total liabilities, return on equity, return on asset, net profit margin has been used to evaluate the financial performance of companies (İskenderoğlu et al., 2015; Çiftçi and Yıldırım, 2020; Konak et al., 2017). Accordingly, it can be stated that such ratios are widely used to measurement of financial performance of companies.

Correspondingly, the objective of this study is to examine the financial performance of energy companies traded in BIST using integrated MCDM methods. In this study, a new model was proposed to evaluate the financial performance of selected companies. For this investigation, the LOPCOW and CRITIC methods were used to calculate the weight of the criteria. Also, the weight of criteria was combined with the AWM method. The financial performance of energy companies was ranked using the CoCoSo method. To the best of the author’s knowledge, this is the first study to assess the financial performance of energy companies using the LOPCOW-CRITIC-based CoCoSo methods. The rest of the paper is structured as follows: The second section of the paper demonstrates the literature review in the relevant field. The third section is associated with the methods used in this study. The fourth section presents the findings of the research. Finally, the conclusion gives a summary and critique of the findings.

1. LITERATURE REVIEW

In this part, a brief synopsis of the relevant literature is presented. Over the past decades, the financial performance of companies has been significantly investigated using different MCDM methods. Some studies in this field are illustrated in Table 1.

Table 1. Previous Research on Financial Performance

Author(s)	Year	Methods	Subject
Moghimi & Anvari	2014	FAHP-TOPSIS	Investigation of the financial performance of Iranian cement companies.

Safaei Ghadikolaei et al.	2014	FAHP, Fuzzy VIKOR, Fuzzy COPRAS, ARAS-F	Evaluation of the financial performance of Iranian automotive companies.
Kandemir & Karataş	2016	GRA-TOPSIS-VIKOR	Analyzing the financial performance of depository banks in BIST.
Gümrah	2016	TOPSIS	Measuring the financial performance of the banks operating in Turkey and Malaysia.
Karaoğlan & Şahin	2018	AHP-VIKOR-TOPSIS GRA-MOORA	Examining the financial performance of BIST chemical petroleum plastic companies.
Şahin & Karacan	2019	GRA-TOPSIS	Evaluation the financial performance of BIST construction companies.
Orhan et al.	2020	CRITIC-TOPSIS	Investigation of the financial performance of Istanbul Bus Companies Trade Inc.
Akbulut	2020	CRITIC-MABAC	Analyzing the financial performance of BIST cement companies.
Marjanović & Popović	2020	CRITIC-TOPSIS	Financial performance analysis of Serbian banks.
Mercan & Çetin	2020	COPRAS-VIKOR	Measuring the financial performance of BIST electricity companies.
Topal	2021	ENTROPY-CoCoSo	Financial performance analysis of electricity companies in Fortune 500 list.
Gürkan & Aldoury	2021	TOPSIS	Examining the financial performance of BIST technology companies.
Şimşek	2022	AHP-SV-WEDBA	Evaluation of the financial performance of Turkish Banking sector.
Kınalı	2022	ENTROPY-TOPSIS	Analyzing the financial performance of enterprises operating in BIST transportation index.
Bektaş	2022	MEREC-LOPCOW-CoCoSo-EDAS	Measuring the financial performance of Turkish insurance sector for the period of 2002-2021.

Nguyen et al.	2022	CRITIC-DEMATEL-TOPSIS	Financial performance analysis of Vietnamese commercial banks under Covid-19 impacts.
Kurt & Kablan	2022	TOPSIS-MABAC	Analyzing the financial performance of airlines trading in BIST transportation index.
Say	2022	ARAS-COPRAS	Evaluation of the financial performance of BIST technology companies.
Soy Temür & Tulum	2022	CRITIC-CoCoSo	Financial performance analysis of BIST technology companies.
Ersoy	2023	LOPCOW-RSMVC	Investigation of the financial performance of BIST retail and trade companies.
Kavas et al.	2023	TOPSIS-MOORA	Financial performance analysis of BIST electricity, gas, and steam companies.
Süslü & Hızlıer	2023	CRITIC-TOPSIS-MULTIMOORA	Examining the financial performance of BIST sports companies.

In reviewing the literature, a considerable amount of research has been conducted for the evaluation of the financial performance of companies using different MCDM methods. Much of the current literature on financial performance focuses on companies traded on BIST. Also, previous research has revealed that some methods, such as CRITIC, TOPSIS, and VIKOR, are widely used in the evaluation of financial performance. However, very few studies have investigated the financial performance of companies using new MCDM methods such as CoCoSo and LOPCOW. Accordingly, the present study aims to contribute to the existing literature by proposing a new model.

2. METHODOLOGY

2.1. LOPCOW

The Logarithmic Percentage Change-driven Objective Weighting (LOPCOW) method was proposed by Ecer and Pamucar in 2022. It has recently been proposed as one of the new weighting methods as an objective approach. The application steps of the LOPCOW method are follows (Ecer & Pamucar, 2022):

Step 1. Initial decision matrix is formed using Eq. (1)

$$IDM = \begin{bmatrix} x_{11} & \dots & x_{1j} & \dots & r_{1n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ x_{m1} & \dots & x_{mj} & \dots & x_{mn} \end{bmatrix} \quad (1)$$

Step 2. According to Eqs. (2-3), the decision matrix is normalized.

$r_{ij} = \frac{x_{max} - x_{ij}}{x_{max} - x_{min}}$, if j is a cost criterion (2)

$r_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}}$, if j is a benefit criterion (3)

Step 3. Percentage values (PV) of each criterion is determined based on Eq. (4).

$$PV_{ij} = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} r_{ij}^2}{m}}}{\sigma} \right) . 100 \right| \quad (4)$$

Step 4. Calculate the weights of the criteria using Eq. (5).

$$w_j = \frac{PV_{ij}}{\sum_{i=1}^{n} PV_{ij}} \tag{5}$$

2.2. CRITIC

The Criteria Importance Through Intercriteria Correlation (CRITIC) method was developed by Diakoulaki et al. in 1995. It's one of the well-known objective weighting methods. The application steps of the CRITIC method are as follows (Diakoulaki et al., 1995):

Step 1. Firstly, initial decision matrix is formed.

Step 2. Then, decision matrix is normalized using Eq. (6-7).

$$x_{ij} = \frac{r_{ij} - r_i^-}{r_i^t - r_i^-}; \tag{6}$$

$$x_{ij} = \frac{r_{ij} - r_i^+}{r_i^- - r_i^+}; \tag{7}$$

Step 3. Eq. [8-9] is used to determine the correlation coefficient among attributes.

$$\sqrt{\sum_{i=1}^{m} \left(x_{ij} - \bar{x}_j\right)^2 \sum_{i=1}^{m} (x_{ik} - \bar{x}_k)^2} \tag{8}$$

$$\bar{x}_j = \frac{1}{n} \sum_{j=1}^{n} x_{ij}; \tag{9}$$

Step 4. At first, the standard deviation of each attribute is estimated by Eq. [10].

$$\sigma_j = \sqrt{\frac{1}{n-1} \sum_{j=1}^{n} \left(x_{ij} - \bar{x}_j\right)^2}; \qquad i = 1, \ldots\ldots\ldots\ldots\ldots, n \tag{10}$$

Then, the index (C) is calculated using Eq. [11].

$$C_J = \sigma_j \sum_{k=1}^{n} (1 - \rho_{jk}); \tag{11}$$

Step 5. The weights of the attributes are determined by Eq. [12].

$$w_j = \frac{C_j}{\sum_{j=1}^{n} C_j}; \qquad j = 1, \ldots\ldots\ldots\ldots\ldots, n \tag{12}$$

For the final ranking, the attribute weights are ranked in descending order.

2.3. Aggregate Weighting Method (AWM)

According to Eq. (13), the aggregated weight is determined (Ighravwe & Babatunde, 2018).

$$W_{Aggregated} = \Delta W_{sj} + (1 - \Delta)\, W_{oj} \tag{13}$$

where W_{sj} and W_{oj} symbolize the subjective and objective weights of the criteria and Δ represents the contribution factor. Keshavarz Ghorabaee et al. [2017] proposed using values of Δ from 0 to 1. Therefore, for this investigation, Δ = 0.5 was taken.

2.4. CoCoSo

Combined Compromise Solution (CoCoSo) method was proposed by Yazdani, Zarate, Zavadskas and Turskis in 2019. This method is based on an integrated simple additive weighting and exponentially weighted product model. The application steps of the CoCoSo method are as follows (Yazdani et al., 2019):

Step 1. Initial decision matrix is determined as shown below:

$$x_{ij} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}; i = 1,2,\dots,m; j = 1,2,\dots,n \quad (14)$$

Step 2. The decision matrix is normalized based on compromise normalization equation (Eqs. 15-16).

$$r_{ij} = \frac{x_{ij} - \min\limits_{i}(x_{ij})}{\max\limits_{i}(x_{ij}) - \min\limits_{i}(x_{ij})}; \text{ for benefit criterion} \quad (15)$$

$$r_{ij} = \frac{\max\limits_{i}(x_{ij}) - x_{ij}}{\max\limits_{i}(x_{ij}) - \min\limits_{i}(x_{ij})}; \text{ for cost criterion} \quad (16)$$

Step 3. The total of the weighted comparability sequence and the whole of the power weight of comparability sequences for each alternative is calculated using Eqs. (17-18).

$$S_i = \sum_{i=1}^{n} (w_j r_{ij}) \quad (17)$$

$$P_i = \sum_{i=1}^{n} (r_{ij})^{w_j} \quad (18)$$

Step 4. Relative weights of the alternatives are determined based on Eqs. (19-21). In this step, three appraisal score strategies are computed.

$$ʒ_{ia} = \frac{P_i + S_i}{\sum_{i=1}^{m}(P_i + S_i)'} \quad (19)$$

$$ʒ_{ib} = \frac{S_i}{\min\limits_{i}(S_i)} + \frac{P_i}{\min\limits_{i}(P_i)'} \quad (20)$$

$$ʒ_{ic} = \frac{\lambda S_i + (1-\lambda)P_i}{\lambda \max\limits_{i}(S_i) - (1-\lambda)\max\limits_{i}(P_i)}; 0 \le \lambda \le 1 \quad (21)$$

Step 5. The final ranking of the alternatives is determined according to k_i values.

$$ʒ_i = (ʒ_{ia} ʒ_{ib} ʒ_{ic})^{\frac{1}{3}} + \frac{1}{3}(ʒ_{ia} + ʒ_{ib} + ʒ_{ic}) \quad (22)$$

3. APPLICATIONS AND RESULTS

In this study, the financial performance of energy companies traded in BIST has been examined. In this context, financial data for the year 2022 has been used. The data has been obtained from finnet2000plus. Information regarding the financial ratios used in the study is shown in Table 2.

Table 2. Financial Ratios

	Ratios	**Calculation Method**	**Symbol**
Liquidity Ratios	Current Ratio	Current assets/ Current Liabilities	CR
	Liquidity ratio	(Current Assets- (Inventories + Receivables)) / Current Liabilities	LR
	Cash Ratio	(Cash + Marketable Securities) / Current Liabilities	CAR
Efficient Ratios	Receivables turnover rate	Net Sales / (S.T. Trade Receivables + L.T. Trade Receivables)	RTO

	Asset turnover rate	Net Sales/ Total Assets	ATR
	Equity Turnover rate	Net Sales / Shareholders' Equity	ETR
	Inventory Turnover Rate	Cost of Goods Sold/ Inventory at start of year	ITR
Financial structure Ratios	Leverage ratio	Total Liabilities / Total Assets	LR
	Ratio of Short-Term Debt to Total liabilities	STD / Total liabilities	STD
	Ratio of Long-Term debts to Total liabilities	LTD / Total liabilities	LTD
Profitability Ratios	Return on equity	Net Profit / Shareholders' Equity	ROE
	Return on assets	Net Profit / Total Assets	ROA
	Net profit margin	Net Profit / Net Sales	NPM

Source: İskenderoğlu et al., 2015; Konak et al., 2017; Çiftçi and Yıldırım, 2020.

3.1. The results obtained from the LOPCOW method

In this section, the application results of the LOPCOW method are presented. Firstly, initial decision matrix was formed based on Eq. (1), and shown in Table 2. Then, the decision matrix was normalized using Eqs. (2-3) and the results are presented in Table 3.

Table 3. Decision Matrix

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
	benefit	**benefit**	**benefit**	**benefit**	**cost**	**benefit**	**benefit**	**cost**	**cost**	**cost**	**benefit**	**benefit**	**benefit**
AKENR	1,11	1,09	39,31	14,28	830,36	0,96	2,98	74,63	20,07	0,80	-43,00	-8,80	-9,21
AKFYE	0,60	0,59	37,77	5,49	0,00	0,15	0,35	60,56	22,18	0,78	11,23	4,33	28,14
AKSEN	1,43	1,38	15,59	5,61	1,69	155,32	2,41	42,95	55,91	0,44	33,97	16,93	9,99
AKSUE	0,20	0,19	5,22	5,08	35,04	0,31	2,19	88,16	44,99	0,55	17,34	2,32	7,38
AYDEM	1,91	1,90	103,19	3,34	152,50	0,13	0,22	51,74	8,73	0,91	7,57	3,52	26,74
AYEN	1,46	1,45	90,56	15,43	0,00	0,89	1,57	55,17	41,57	0,58	56,03	20,96	23,46
BIOEN	0,96	0,76	2,27	5,47	8,22	0,49	1,74	77,94	48,74	0,51	49,19	12,33	25,25
CANTE	1,69	0,96	16,88	14,66	9,70	0,88	1,32	41,93	38,97	0,61	60,84	32,51	36,77
ARASE	1,25	1,14	15,45	14,10	191,13	3,36	7,44	67,06	65,60	0,34	49,72	18,70	5,56
ENJSA	0,70	0,65	26,78	7,29	51,87	1,87	3,91	63,55	83,09	0,83	93,77	32,03	17,17
ESEN	1,88	1,82	58,09	1,51	32,79	0,14	0,16	26,24	45,81	0,54	13,35	7,63	55,33
GWIND	8,46	7,76	685,27	13,26	260,74	0,56	0,63	37,41	18,63	0,81	72,30	49,31	87,93
HUNER	0,36	0,33	16,75	15,44	43,37	0,13	0,23	53,27	22,01	0,78	11,60	4,88	37,12
KARYE	0,80	0,78	58,15	12,16	0,00	0,10	0,13	34,15	19,11	0,81	10,48	6,67	64,90
MAGEN	1,98	1,96	64,58	1,26	55,76	0,09	0,11	24,78	43,21	0,19	12,35	9,19	96,93
NATEN	1,85	1,78	62,43	1,50	25,49	0,14	0,16	26,37	46,29	0,54	19,82	7,98	59,06
NTGAZ	2,11	2,03	73,65	7,51	80,79	2,80	0,75	28,96	91,95	0,08	81,57	57,17	20,42
ODAS	1,43	0,81	49,99	19,71	9,67	0,83	0,41	43,64	59,11	1,18	48,97	25,53	30,77
PAMEL	0,12	0,11	8,78	58,25	0,00	0,07	0,07	33,67	48,03	0,52	33,05	22,54	326,21
SMRTG	1,34	1,03	17,30	3,03	5,93	1,29	2,81	69,89	93,72	0,06	50,78	14,53	11,28
ZEDUR	0,51	0,46	15,77	4,62	141,57	0,10	0,13	33,75	19,58	0,80	7,76	4,99	47,79
ZOREN	0,60	0,56	13,08	5,77	45,91	0,58	1,71	73,89	45,47	0,55	0,93	0,22	0,37
max	8,46	7,76	685,27	58,25	830,36	155,32	7,44	88,16	93,72	1,18	93,77	57,17	326,21
min	0,12	0,11	2,27	1,26	0,00	0,07	0,07	24,78	8,73	0,06	-43,00	-8,80	-9,21

Table 4. Normalized decision matrix

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
AKENR	0,1187	0,1281	0,0542	0,2285	0,0000	0,0057	0,3941	0,2135	0,8666	0,3423	0,0000	0,0000	0,0000
AKFYE	0,0576	0,0627	0,0520	0,0742	1,0000	0,0005	0,0382	0,4355	0,8417	0,3610	0,3965	0,1990	0,1114
AKSEN	0,1571	0,1660	0,0195	0,0763	0,9980	1,0000	0,3168	0,7133	0,4449	0,6611	0,5628	0,3900	0,0572
AKSUE	0,0096	0,0105	0,0043	0,0670	0,9578	0,0015	0,2870	0,0000	0,5734	0,5640	0,4412	0,1686	0,0495
AYDEM	0,2146	0,2340	0,1478	0,0365	0,8163	0,0004	0,0204	0,5746	1,0000	0,2414	0,3697	0,1868	0,1072
AYEN	0,1607	0,1752	0,1293	0,2486	1,0000	0,0053	0,2037	0,5205	0,6136	0,5336	0,7241	0,4511	0,0974
BIOEN	0,1007	0,0850	0,0000	0,0739	0,9901	0,0027	0,2262	0,1612	0,5292	0,5974	0,6741	0,3203	0,1027
CANTE	0,1882	0,1111	0,0214	0,2351	0,9883	0,0052	0,1690	0,7294	0,6442	0,5105	0,7592	0,6262	0,1371
ARASE	0,1355	0,1346	0,0193	0,2253	0,7698	0,0212	1,0000	0,3329	0,3309	0,7474	0,6779	0,4169	0,0440
ENJSA	0,0695	0,0706	0,0359	0,1058	0,9375	0,0116	0,5214	0,3883	0,1251	0,3142	1,0000	0,6189	0,0786
ESEN	0,2110	0,2235	0,0817	0,0044	0,9605	0,0005	0,0118	0,9770	0,5637	0,5713	0,4120	0,2491	0,1924
GWIND	1,0000	1,0000	1,0000	0,2106	0,6860	0,0032	0,0754	0,8007	0,8835	0,3294	0,8430	0,8809	0,2896
HUNER	0,0288	0,0288	0,0212	0,2488	0,9478	0,0004	0,0219	0,5505	0,8437	0,3596	0,3992	0,2074	0,1381
KARYE	0,0815	0,0876	0,0818	0,1913	1,0000	0,0002	0,0078	0,8522	0,8779	0,3338	0,3910	0,2345	0,2209
MAGEN	0,2230	0,2418	0,0912	0,0000	0,9328	0,0001	0,0050	1,0000	0,5943	0,8869	0,4047	0,2727	0,3164
NATEN	0,2074	0,2183	0,0881	0,0042	0,9693	0,0005	0,0115	0,9749	0,5581	0,5755	0,4593	0,2544	0,2035
NTGAZ	0,2386	0,2510	0,1045	0,1097	0,9027	0,0176	0,0918	0,9340	0,0208	0,9817	0,9108	1,0000	0,0883
ODAS	0,1571	0,0915	0,0699	0,3237	0,9884	0,0049	0,0456	0,7024	0,4072	0,0000	0,6724	0,5204	0,1192
PAMEL	0,0000	0,0000	0,0095	1,0000	1,0000	0,0000	0,0000	0,8597	0,5376	0,5910	0,5560	0,4751	1,0000
SMRTG	0,1463	0,1203	0,0220	0,0311	0,9929	0,0079	0,3720	0,2883	0,0000	1,0000	0,6857	0,3536	0,0611
ZEDUR	0,0468	0,0458	0,0198	0,0590	0,8295	0,0002	0,0074	0,8585	0,8723	0,3417	0,3711	0,2090	0,1699
ZOREN	0,0576	0,0588	0,0158	0,0791	0,9447	0,0033	0,2222	0,2251	0,5677	0,5683	0,3212	0,1367	0,0286
Mean square	0,1641	0,1611	0,0950	0,1651	0,8915	0,0497	0,1841	0,5951	0,5771	0,5187	0,5469	0,3714	0,1642
Std dev.	0,2004	0,2025	0,2065	0,2098	0,2164	0,2123	0,2383	0,3027	0,2794	0,2437	0,2298	0,2424	0,2034

Once the decision matrix was normalized, PV values for each criterion was calculated, and the results are demonstrated in Table 5.

Table 5. PV values of criteria

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
PV	-19,997	-22,830	-77,666	-23,934	141,563	-145,276	-25,833	67,601	72,528	75,560	86,711	42,678	-21,389

According to Eq. (5), the weight of criteria was determined and shown in Table 6.

Table 6. The weight of criteria

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
w_j	-0,1336	-0,1525	-0,5188	-0,1599	0,9455	-0,9703	-0,1725	0,4515	0,4844	0,5047	0,5792	0,2851	-0,1429
Rank	7	9	12	10	1	13	11	5	4	3	2	6	8

The results of the LOPCOW method showed that ITR, ROE and LTD were the most important criteria, while the ETR, CAR and ATR were the least important criteria, respectively.

3.2. The results obtained from the CRITIC method

In this section, the application results of the CRITIC method are presented. After the initial decision matrix was formed, the decision matrix was normalized according to Eqs. (6-7), and shown in Table 7.

Table 7. Normalized decision matrix

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
AKENR	0,1187	0,1281	0,0542	0,2285	0,0000	0,0057	0,3941	0,2135	0,8666	0,3423	0,0000	0,0000	0,0000
AKFYE	0,0576	0,0627	0,0520	0,0742	1,0000	0,0005	0,0382	0,4355	0,8417	0,3610	0,3965	0,1990	0,1114
AKSEN	0,1571	0,1660	0,0195	0,0763	0,9980	1,0000	0,3168	0,7133	0,4449	0,6611	0,5628	0,3900	0,0572
AKSUE	0,0096	0,0105	0,0043	0,0670	0,9578	0,0015	0,2870	0,0000	0,5734	0,5640	0,4412	0,1686	0,0495
AYDEM	0,2146	0,2340	0,1478	0,0365	0,8163	0,0004	0,0204	0,5746	1,0000	0,2414	0,3697	0,1868	0,1072
AYEN	0,1607	0,1752	0,1293	0,2486	1,0000	0,0053	0,2037	0,5205	0,6136	0,5336	0,7241	0,4511	0,0974
BIOEN	0,1007	0,0850	0,0000	0,0739	0,9901	0,0027	0,2262	0,1612	0,5292	0,5974	0,6741	0,3203	0,1027
CANTE	0,1882	0,1111	0,0214	0,2351	0,9883	0,0052	0,1690	0,7294	0,6442	0,5105	0,7592	0,6262	0,1371
ARASE	0,1355	0,1346	0,0193	0,2253	0,7698	0,0212	1,0000	0,3329	0,3309	0,7474	0,6779	0,4169	0,0440
ENJSA	0,0695	0,0706	0,0359	0,1058	0,9375	0,0116	0,5214	0,3883	0,1251	0,3142	1,0000	0,6189	0,0786
ESEN	0,2110	0,2235	0,0817	0,0044	0,9605	0,0005	0,0118	0,9770	0,5637	0,5713	0,4120	0,2491	0,1924
GWIND	1,0000	1,0000	1,0000	0,2106	0,6860	0,0032	0,0754	0,8007	0,8835	0,3294	0,8430	0,8809	0,2896
HUNER	0,0288	0,0288	0,0212	0,2488	0,9478	0,0004	0,0219	0,5505	0,8437	0,3596	0,3992	0,2074	0,1381
KARYE	0,0815	0,0876	0,0818	0,1913	1,0000	0,0002	0,0078	0,8522	0,8779	0,3338	0,3910	0,2345	0,2209
MAGEN	0,2230	0,2418	0,0912	0,0000	0,9328	0,0001	0,0050	1,0000	0,5943	0,8869	0,4047	0,2727	0,3164
NATEN	0,2074	0,2183	0,0881	0,0042	0,9693	0,0005	0,0115	0,9749	0,5581	0,5755	0,4593	0,2544	0,2035
NTGAZ	0,2386	0,2510	0,1045	0,1097	0,9027	0,0176	0,0918	0,9340	0,0208	0,9817	0,9108	1,0000	0,0883
ODAS	0,1571	0,0915	0,0699	0,3237	0,9884	0,0049	0,0456	0,7024	0,4072	0,0000	0,6724	0,5204	0,1192
PAMEL	0,0000	0,0000	0,0095	1,0000	1,0000	0,0000	0,0000	0,8597	0,5376	0,5910	0,5560	0,4751	1,0000
SMRTG	0,1463	0,1203	0,0220	0,0311	0,9929	0,0079	0,3720	0,2883	0,0000	1,0000	0,6857	0,3536	0,0611
ZEDUR	0,0468	0,0458	0,0198	0,0590	0,8295	0,0002	0,0074	0,8585	0,8723	0,3417	0,3711	0,2090	0,1699
ZOREN	0,0576	0,0588	0,0158	0,0791	0,9447	0,0033	0,2222	0,2251	0,5677	0,5683	0,3212	0,1367	0,0286

Then, the correlation coefficient for each attribute was calculated based on Eqs. (8-9) and the results are demonstrated in Table 8.

Table 8. The correlation coefficient

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
CR	1,0000	0,9927	0,9613	-0,1029	-0,2066	-0,0067	-0,1199	0,3080	0,1475	-0,0500	0,3379	0,5463	0,0379
LR	0,9927	1,0000	0,9637	-0,1247	-0,2275	0,0062	-0,1241	0,3155	0,1693	-0,0232	0,2951	0,5092	0,0452
CAR	0,9613	0,9637	1,0000	0,0029	-0,2178	-0,0832	-0,1735	0,2391	0,2745	-0,1904	0,2748	0,4793	0,1184
RTR	-0,1029	-0,1247	0,0029	1,0000	-0,0150	-0,0952	-0,0636	0,1254	0,0328	-0,1505	0,0918	0,2127	0,7891
ITR	-0,2066	-0,2275	-0,2178	-0,0150	1,0000	0,1056	-0,2675	0,2280	-0,3007	0,1886	0,4391	0,2061	0,1929
ATR	-0,0067	0,0062	-0,0832	-0,0952	0,1056	1,0000	0,1449	0,0816	-0,1239	0,1407	0,0301	0,0312	-0,1265
ETR	-0,1199	-0,1241	-0,1735	-0,0636	-0,2675	0,1449	1,0000	-0,5822	-0,4481	0,2541	0,2362	0,0397	-0,3913
LR	0,3080	0,3155	0,2391	0,1254	0,2280	0,0816	-0,5822	1,0000	0,0982	0,0343	0,1041	0,3472	0,4702
STD	0,1475	0,1693	0,2745	0,0328	-0,3007	-0,1239	-0,4481	0,0982	1,0000	-0,5952	-0,6272	-0,4744	0,1049
LTD	-0,0500	-0,0232	-0,1904	-0,1505	0,1886	0,1407	0,2541	0,0343	-0,5952	1,0000	0,2020	0,1835	0,0366
ROE	0,3379	0,2951	0,2748	0,0918	0,4391	0,0301	0,2362	0,1041	-0,6272	0,2020	1,0000	0,8788	0,0319
ROA	0,5463	0,5092	0,4793	0,2127	0,2061	0,0312	0,0397	0,3472	-0,4744	0,1835	0,8788	1,0000	0,1627
NPM	0,0379	0,0452	0,1184	0,7891	0,1929	-0,1265	-0,3913	0,4702	0,1049	0,0366	0,0319	0,1627	1,0000

At this step, the standard deviation of each attribute was calculated using Eq. (10). Afterwards, the index (C) was determined based on Eq. (11). The results are presented in Table 9.

Table 9. The index *(C)*

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
CR	0,0000	0,0073	0,0387	1,1029	1,2066	1,0067	1,1199	0,6920	0,8525	1,0500	0,6621	0,4537	0,9621
LR	0,0073	0,0000	0,0363	1,1247	1,2275	0,9938	1,1241	0,6845	0,8307	1,0232	0,7049	0,4908	0,9548
CAR	0,0387	0,0363	0,0000	0,9971	1,2178	1,0832	1,1735	0,7609	0,7255	1,1904	0,7252	0,5207	0,8816
RTR	1,1029	1,1247	0,9971	0,0000	1,0150	1,0952	1,0636	0,8746	0,9672	1,1505	0,9082	0,7873	0,2109
ITR	1,2066	1,2275	1,2178	1,0150	0,0000	0,8944	1,2675	0,7720	1,3007	0,8114	0,5609	0,7939	0,8071
ATR	1,0067	0,9938	1,0832	1,0952	0,8944	0,0000	0,8551	0,9184	1,1239	0,8593	0,9699	0,9688	1,1265
ETR	1,1199	1,1241	1,1735	1,0636	1,2675	0,8551	0,0000	1,5822	1,4481	0,7459	0,7638	0,9603	1,3913
LR	0,6920	0,6845	0,7609	0,8746	0,7720	0,9184	1,5822	0,0000	0,9018	0,9657	0,8959	0,6528	0,5298
STD	0,8525	0,8307	0,7255	0,9672	1,3007	1,1239	1,4481	0,9018	0,0000	1,5952	1,6272	1,4744	0,8951
LTD	1,0500	1,0232	1,1904	1,1505	0,8114	0,8593	0,7459	0,9657	1,5952	0,0000	0,7980	0,8165	0,9634
ROE	0,6621	0,7049	0,7252	0,9082	0,5609	0,9699	0,7638	0,8959	1,6272	0,7980	0,0000	0,1212	0,9681
ROA	0,4537	0,4908	0,5207	0,7873	0,7939	0,9688	0,9603	0,6528	1,4744	0,8165	0,1212	0,0000	0,8373
NPM	0,9621	0,9548	0,8816	0,2109	0,8071	1,1265	1,3913	0,5298	0,8951	0,9634	0,9681	0,8373	0,0000

Eq. (12) was used to determine the weight of criteria. For the final ranking, the criteria weights were ranked in descending order, and shown in Table 10.

Table 10. The weight of criteria

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
σ_j	0,2004	0,2025	0,2065	0,2098	0,2164	0,2123	0,2383	0,3027	0,2794	0,2437	0,2298	0,2424	0,2034
C_j	1,8348	1,8632	1,9307	2,3701	2,5700	2,5258	3,2160	3,0968	3,8400	2,9165	2,2302	2,1519	2,1415
w_j	0,0561	0,0570	0,0591	0,0725	0,0786	0,0773	0,0984	0,0947	0,1175	0,0892	0,0682	0,0658	0,0655
Rank	13	12	11	7	5	6	2	3	1	4	8	9	10

According to results obtained from the CRITIC method, STD, ETR and LR were the most important criteria, while CAR, LR and CR were the least important criteria, respectively.

3.3. The results obtained from the AWM method

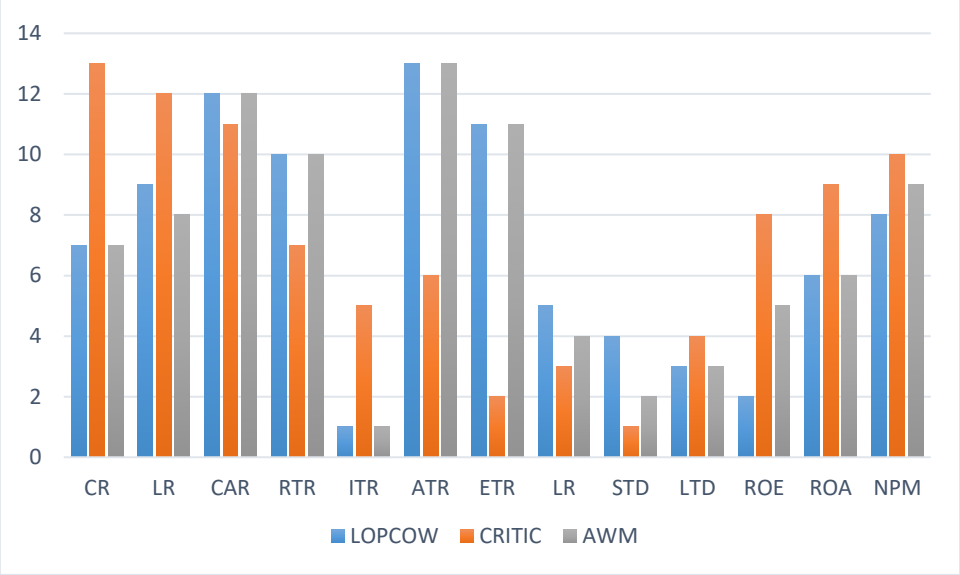
In this section, the results obtained from the LOPCOW and CRITIC methods are combined using the AWM method (Eq.13), and the results are shown in Table 11.

Table 11. Final weights obtained from the LOPCOW, CRITIC and AWM methods.

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
LOPCOW													
w_j	-0,1336	-0,1525	-0,5188	-0,1599	0,9455	-0,9703	-0,1725	0,4515	0,4844	0,5047	0,5792	0,2851	-0,1429
Rank	7	9	12	10	1	13	11	5	4	3	2	6	8
CRITIC													
w_j	0,0561	0,0570	0,0591	0,0725	0,0786	0,0773	0,0984	0,0947	0,1175	0,0892	0,0682	0,0658	0,0655
Rank	13	12	11	7	5	6	2	3	1	4	8	9	10
AWM													
w_j	-0,0638	-0,0739	-0,2605	-0,0986	0,6321	-0,6375	-0,1443	0,3637	0,4839	0,3829	0,3360	0,1596	-0,0796
Rank	7	8	12	10	1	13	11	4	2	3	5	6	9

The results of the AWM method showed that ITR, STD and LTD were the most important criteria, ETR, CAR and ATR were the least important criteria, respectively. The overall results obtained from the three different approaches are presented in Figure 1.

Figure 1. The final ranking of the criteria



Once the weight of criteria was determined, the alternatives were ranked using the CoCoSo method. In the following section, the results of the CoCoSo method are presented.

3.4. The results obtained from the CoCoSo method

In this section, the application steps of the CoCoSo method are demonstrated. According to Eqs. (15-16), the decision matrix was normalized and the results are shown in Table 12.

Table 12. Normalized decision matrix

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM
AKENR	0,1187	0,1281	0,0542	0,2285	0,0000	0,0057	0,3941	0,2135	0,8666	0,3423	0,0000	0,0000	0,0000
AKFYE	0,0576	0,0627	0,0520	0,0742	1,0000	0,0005	0,0382	0,4355	0,8417	0,3610	0,3965	0,1990	0,1114
AKSEN	0,1571	0,1660	0,0195	0,0763	0,9980	1,0000	0,3168	0,7133	0,4449	0,6611	0,5628	0,3900	0,0572
AKSUE	0,0096	0,0105	0,0043	0,0670	0,9578	0,0015	0,2870	0,0000	0,5734	0,5640	0,4412	0,1686	0,0495
AYDEM	0,2146	0,2340	0,1478	0,0365	0,8163	0,0004	0,0204	0,5746	1,0000	0,2414	0,3697	0,1868	0,1072
AYEN	0,1607	0,1752	0,1293	0,2486	1,0000	0,0053	0,2037	0,5205	0,6136	0,5336	0,7241	0,4511	0,0974
BIOEN	0,1007	0,0850	0,0000	0,0739	0,9901	0,0027	0,2262	0,1612	0,5292	0,5974	0,6741	0,3203	0,1027
CANTE	0,1882	0,1111	0,0214	0,2351	0,9883	0,0052	0,1690	0,7294	0,6442	0,5105	0,7592	0,6262	0,1371
ARASE	0,1355	0,1346	0,0193	0,2253	0,7698	0,0212	1,0000	0,3329	0,3309	0,7474	0,6779	0,4169	0,0440
ENJSA	0,0695	0,0706	0,0359	0,1058	0,9375	0,0116	0,5214	0,3883	0,1251	0,3142	1,0000	0,6189	0,0786
ESEN	0,2110	0,2235	0,0817	0,0044	0,9605	0,0005	0,0118	0,9770	0,5637	0,5713	0,4120	0,2491	0,1924
GWIND	1,0000	1,0000	1,0000	0,2106	0,6860	0,0032	0,0754	0,8007	0,8835	0,3294	0,8430	0,8809	0,2896
HUNER	0,0288	0,0288	0,0212	0,2488	0,9478	0,0004	0,0219	0,5505	0,8437	0,3596	0,3992	0,2074	0,1381
KARYE	0,0815	0,0876	0,0818	0,1913	1,0000	0,0002	0,0078	0,8522	0,8779	0,3338	0,3910	0,2345	0,2209
MAGEN	0,2230	0,2418	0,0912	0,0000	0,9328	0,0001	0,0050	1,0000	0,5943	0,8869	0,4047	0,2727	0,3164
NATEN	0,2074	0,2183	0,0881	0,0042	0,9693	0,0005	0,0115	0,9749	0,5581	0,5755	0,4593	0,2544	0,2035
NTGAZ	0,2386	0,2510	0,1045	0,1097	0,9027	0,0176	0,0918	0,9340	0,0208	0,9817	0,9108	1,0000	0,0883
ODAS	0,1571	0,0915	0,0699	0,3237	0,9884	0,0049	0,0456	0,7024	0,4072	0,0000	0,6724	0,5204	0,1192
PAMEL	0,0000	0,0000	0,0095	1,0000	1,0000	0,0000	0,0000	0,8597	0,5376	0,5910	0,5560	0,4751	1,0000
SMRTG	0,1463	0,1203	0,0220	0,0311	0,9929	0,0079	0,3720	0,2883	0,0000	1,0000	0,6857	0,3536	0,0611
ZEDUR	0,0468	0,0458	0,0198	0,0590	0,8295	0,0002	0,0074	0,8585	0,8723	0,3417	0,3711	0,2090	0,1699
ZOREN	0,0576	0,0588	0,0158	0,0791	0,9447	0,0033	0,2222	0,2251	0,5677	0,5683	0,3212	0,1367	0,0286

According to Eqs. (17-18), the total of the weighted comparability sequence and the weight of comparability sequences for each alternative was calculated, and the results are presented in Table 13 and 14, respectively.

Table 13. Weighted comparability sequence *(S_i)*

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM	S_i
AKENR	-0,0076	-0,0095	-0,0141	-0,0225	0,0000	-0,0037	-0,0569	0,0776	0,4193	0,1311	0,0000	0,0000	0,0000	0,5138
AKFYE	-0,0037	-0,0046	-0,0135	-0,0073	0,6321	-0,0003	-0,0055	0,1584	0,4073	0,1382	0,1332	0,0318	-0,0089	1,4661
AKSEN	-0,0100	-0,0123	-0,0051	-0,0075	0,6308	-0,6375	-0,0457	0,2595	0,2153	0,2531	0,1891	0,0622	-0,0046	0,8919
AKSUE	-0,0006	-0,0008	-0,0011	-0,0066	0,6055	-0,0010	-0,0414	0,0000	0,2774	0,2160	0,1482	0,0269	-0,0039	1,2225
AYDEM	-0,0137	-0,0173	-0,0385	-0,0036	0,5160	-0,0002	-0,0029	0,2090	0,4839	0,0924	0,1242	0,0298	-0,0085	1,3791
AYEN	-0,0102	-0,0129	-0,0337	-0,0245	0,6321	-0,0034	-0,0294	0,1893	0,2969	0,2043	0,2433	0,0720	-0,0078	1,5238
BIOEN	-0,0064	-0,0063	0,0000	-0,0073	0,6259	-0,0017	-0,0326	0,0587	0,2561	0,2287	0,2265	0,0511	-0,0082	1,3926
CANTE	-0,0120	-0,0082	-0,0056	-0,0232	0,6247	-0,0033	-0,0244	0,2653	0,3117	0,1955	0,2551	0,0999	-0,0109	1,6756
ARASE	-0,0086	-0,0100	-0,0050	-0,0222	0,4866	-0,0135	-0,1443	0,1211	0,1601	0,2862	0,2278	0,0665	-0,0035	1,1446
ENJSA	-0,0044	-0,0052	-0,0093	-0,0104	0,5926	-0,0074	-0,0753	0,1412	0,0605	0,1203	0,3360	0,0988	-0,0063	1,2374
ESEN	-0,0135	-0,0165	-0,0213	-0,0004	0,6072	-0,0003	-0,0017	0,3554	0,2728	0,2187	0,1384	0,0397	-0,0153	1,5785
GWIND	-0,0638	-0,0739	-0,2605	-0,0208	0,4336	-0,0020	-0,0109	0,2913	0,4275	0,1261	0,2832	0,1406	-0,0230	1,2705
HUNER	-0,0018	-0,0021	-0,0055	-0,0245	0,5991	-0,0002	-0,0032	0,2002	0,4083	0,1377	0,1341	0,0331	-0,0110	1,4751
KARYE	-0,0052	-0,0065	-0,0213	-0,0189	0,6321	-0,0001	-0,0011	0,3100	0,4248	0,1278	0,1314	0,0374	-0,0176	1,6104
MAGEN	-0,0142	-0,0179	-0,0238	0,0000	0,5897	-0,0001	-0,0007	0,3637	0,2876	0,3396	0,1360	0,0435	-0,0252	1,7034
NATEN	-0,0132	-0,0161	-0,0229	-0,0004	0,6127	-0,0003	-0,0017	0,3546	0,2700	0,2204	0,1543	0,0406	-0,0162	1,5980
NTGAZ	-0,0152	-0,0185	-0,0272	-0,0108	0,5706	-0,0112	-0,0133	0,3397	0,0101	0,3759	0,3060	0,1596	-0,0070	1,6657
ODAS	-0,0100	-0,0068	-0,0182	-0,0319	0,6248	-0,0031	-0,0066	0,2555	0,1971	0,0000	0,2259	0,0830	-0,0095	1,3097
PAMEL	0,0000	0,0000	-0,0025	-0,0986	0,6321	0,0000	0,0000	0,3127	0,2601	0,2263	0,1868	0,0758	-0,0796	1,5929
SMRTG	-0,0093	-0,0089	-0,0057	-0,0031	0,6276	-0,0050	-0,0537	0,1049	0,0000	0,3829	0,2304	0,0564	-0,0049	1,3164
ZEDUR	-0,0030	-0,0034	-0,0051	-0,0058	0,5244	-0,0001	-0,0011	0,3123	0,4221	0,1308	0,1247	0,0334	-0,0135	1,5291
ZOREN	-0,0037	-0,0043	-0,0041	-0,0078	0,5972	-0,0021	-0,0321	0,0819	0,2747	0,2176	0,1079	0,0218	-0,0023	1,2470

Table 14. Exponentially weighted comparability sequence *(P_i)*

	CR	LR	CAR	RTR	ITR	ATR	ETR	LR	STD	LTD	ROE	ROA	NPM	P_i
AKENR	1,1455	1,1640	2,1368	1,1566	0,0000	26,8608	1,1439	0,5702	0,9330	0,6633	0,0000	0,0000	****	35,7743
AKFYE	1,1996	1,2271	2,1606	1,2922	1,0000	124,7867	1,6019	0,7391	0,9200	0,6770	0,7328	0,5767	1,1909	138,1046
AKSEN	1,1252	1,1419	2,7892	1,2886	0,9987	1,0000	1,1805	0,8844	0,6757	0,8535	0,8244	0,6420	1,2556	14,6598
AKSUE	1,3448	1,4008	4,1309	1,3052	0,9731	61,9424	1,1974	0,0000	0,7640	0,8031	0,7596	0,5616	1,2703	76,4534
AYDEM	1,1031	1,1133	1,6457	1,3858	0,8796	149,9066	1,7543	0,8175	1,0000	0,5803	0,7158	0,5709	1,1945	162,6675
AYEN	1,1236	1,1374	1,7041	1,1470	1,0000	28,3008	1,2582	0,7886	0,7895	0,7862	0,8972	0,6571	1,2036	40,7934
BIOEN	1,1576	1,1999	****	1,2928	0,9937	43,3555	1,2393	0,5149	0,7350	0,8210	0,8759	0,6222	1,1985	54,0062
CANTE	1,1123	1,1763	2,7229	1,1534	0,9926	28,5231	1,2925	0,8916	0,8083	0,7730	0,9116	0,6924	1,1713	42,2214
ARASE	1,1359	1,1597	2,7969	1,1582	0,8476	11,6714	1,0000	0,6703	0,5855	0,8945	0,8776	0,6489	1,2821	24,7287
ENJSA	1,1852	1,2164	2,3795	1,2478	0,9600	17,1439	1,0986	0,7089	0,3657	0,6419	1,0000	0,6911	1,2243	29,8634
ESEN	1,1043	1,1171	1,9203	1,7076	0,9749	135,8752	1,8979	0,9916	0,7578	0,8070	0,7424	0,5977	1,1402	149,6337
GWIND	1,0000	1,0000	1,0000	1,1660	0,7880	39,2973	1,4524	0,9223	0,9418	0,6537	0,9442	0,7312	1,1037	51,0006
HUNER	1,2538	1,2999	2,7292	1,1469	0,9667	149,9066	1,7363	0,8048	0,9211	0,6760	0,7345	0,5805	1,1706	163,9270
KARYE	1,1733	1,1972	1,9197	1,1771	1,0000	233,2046	2,0149	0,9435	0,9389	0,6570	0,7294	0,5920	1,1277	246,6752
MAGEN	1,1004	1,1106	1,8660	****	0,9570	301,9959	2,1498	1,0000	0,7774	0,9551	0,7379	0,6064	1,0959	314,3524
NATEN	1,1055	1,1190	1,8832	1,7145	0,9805	135,8752	1,9051	0,9908	0,7541	0,8093	0,7700	0,5997	1,1351	149,6420
NTGAZ	1,0957	1,1076	1,8011	1,2434	0,9373	13,1457	1,4115	0,9755	0,1536	0,9930	0,9691	0,7461	1,2130	25,7926
ODAS	1,1252	1,1933	2,0003	1,1176	0,9926	29,7056	1,5617	0,8794	0,6474	0,0000	0,8752	0,6723	1,1844	41,9551

PAMEL	****	****	3,3612	1,0000	1,0000	****	****	0,9465	0,7406	0,8176	0,8210	0,6626	1,0000	10,3495
SMRTG	1,1304	1,1695	2,7028	1,4080	0,9955	21,9683	1,1534	0,6361	0,0000	1,0000	0,8809	0,6321	1,2492	34,9261
ZEDUR	1,2156	1,2560	2,7795	1,3218	0,8886	233,2046	2,0296	0,9460	0,9360	0,6629	0,7167	0,5812	1,1515	247,6901
ZOREN	1,1996	1,2329	2,9452	1,2840	0,9647	38,3077	1,2425	0,5814	0,7604	0,8054	0,6828	0,5432	1,3271	51,8769

Eqs. (19-21) was used to calculate the three-appraisal score. The final ranking of the alternatives was determined according to Eq. (22), and the results are shown in Table 15.

Table 15. Final aggregation and ranking of the alternatives.

	k_{ia}	Ranks	k_{ib}	Ranks	k_{ic}	Ranks	k_i	Final Ranks
AKENR	0,0170	16	4,4566	20	218,3718	16	79,7893	17
AKFYE	0,0653	8	16,1973	8	393,1596	8	275,0828	8
AKSEN	0,0073	21	3,1522	22	182,5940	21	63,3137	21
AKSUE	0,0363	9	9,7663	9	288,0198	9	133,3481	9
AYDEM	0,0767	5	18,4015	5	434,9572	5	355,9087	5
AYEN	0,0198	15	6,9072	14	227,4265	15	88,4846	15
BIOEN	0,0259	10	7,9284	10	249,8678	10	103,0560	10
CANTE	0,0205	13	7,3405	13	229,9348	13	90,6530	13
ARASE	0,0121	20	4,6169	19	199,8719	20	71,8904	20
ENJSA	0,0146	18	5,2936	18	208,6648	18	76,6818	18
ESEN	0,0707	7	17,5302	7	412,8549	7	314,1547	7
GWIND	0,0245	12	7,4005	12	244,6871	12	98,7985	12
HUNER	0,0774	4	18,7100	4	437,1506	4	362,9544	4
KARYE	0,1162	3	26,9687	2	578,1734	3	805,4990	3
MAGEN	0,1479	1	33,6889	1	693,5027	1	1393,9999	1
NATEN	0,0708	6	17,5689	6	412,8786	6	314,5933	6
NTGAZ	0,0128	19	5,7338	17	201,9448	19	74,1888	19
ODAS	0,0202	14	6,6027	15	229,2983	14	88,8555	14
PAMEL	0,0056	22	4,1000	21	175,6021	22	61,2434	22
SMRTG	0,0170	17	5,9367	16	217,3283	17	81,7196	16
ZEDUR	0,1166	2	26,9085	3	579,8616	2	808,7254	2
ZOREN	0,0249	11	7,4394	11	246,1679	11	99,7161	11

According to results obtained from the CoCoSo method, MAGEN, ZEDUR and KARYE had the highest financial performances, ARASE, AKSEN and PAMEL had the lowest financial performances, respectively in 2022. Maliene et al. (2018) stated that it's important to perform sensitivity analysis on MCDM problems. Therefore, the reliability of the results was tested by sensitivity analysis. In the following section, the results of the sensitivity analysis are presented.

3.5. Sensitivity Analysis

In this study, the sensitivity analysis was performed by modifying the λ value. The λ value of each criterion was changed by 0.1. Thus, the robustness of the proposed model was tested under ten different scenarios. The ranking results for each scenario are shown in Table 16.

Table 16. Sensitivity analysis

	λ=0,1	λ=0,2	λ=0,3	λ=0,4	λ=0,5	λ=0,6	λ=0,7	λ=0,8	λ=0,9	λ=1
AKENR	17	17	17	17	17	17	17	17	19	21
AKFYE	8	8	8	8	8	8	8	8	8	8
AKSEN	21	21	21	21	21	21	21	21	22	22
AKSUE	9	9	9	9	9	9	9	9	9	9
AYDEM	5	5	5	5	5	5	5	5	5	5

AYEN	15	15	15	15	15	15	15	14	14	14
BIOEN	10	10	10	10	10	10	10	10	10	10
CANTE	13	13	13	13	13	13	13	13	13	11
ARASE	20	20	20	20	20	20	20	20	20	19
ENJSA	18	18	18	18	18	18	18	18	17	18
ESEN	7	7	7	7	7	7	7	7	7	7
GWIND	12	12	12	12	12	12	12	12	12	13
HUNER	4	4	4	4	4	4	4	4	4	4
KARYE	3	3	3	3	3	3	3	3	3	2
MAGEN	1	1	1	1	1	1	1	1	1	1
NATEN	6	6	6	6	6	6	6	6	6	6
NTGAZ	19	19	19	19	19	19	19	19	18	16
ODAS	14	14	14	14	14	14	14	15	15	15
PAMEL	22	22	22	22	22	22	22	22	21	20
SMRTG	16	16	16	16	16	16	16	16	16	17
ZEDUR	2	2	2	2	2	2	2	2	2	3
ZOREN	11	11	11	11	11	11	11	11	11	12

Based on the results obtained from the sensitivity analysis, the proposed model seems to be validated and reliable. It may be observed that the rank of the alternatives changes a little with the interchanging of the λ value. However, almost all the scenarios; MAGEN, ZEDUR, KARYE, HUNER and AYDEM are in the top five. The sensitivity analysis is evident that, in general, the ranking of the alternatives does not change significantly after modifying the λ value. Thus, it can be concluded that the robustness of the results is carried out by the proposed LOPCOW-CRITIC based CoCoSo model.

CONCLUSION

Financial performance is generally interpreted by examining various financial indicators such as profitability, liquidity, debt, and efficiency. For instance, high profitability ratios indicate that the company has a healthy financial situation, while liquidity ratios can determine the company's ability to pay short-term debts. The financial leverage ratio of companies is important for the sustainability of their financial performance. High debt ratios can be interpreted as negatively affecting the company's future cash flows. When evaluating their financial performance, companies analyze their assets and how efficiently they use their capital, and examine efficiency ratios to obtain information about their financial performance.

Accordingly, this study aimed to investigate the financial performance of energy companies traded in the BIST with LOPCOW-CRITIC-based CoCoSo methods. Initially, the weight of the criteria was determined using two objective methods, namely LOPCOW and CRITIC. Then, the weight of the criteria was combined with AWM. Once the weight of criteria was calculated, the energy companies were ranked using the CoCoSo method. Based on the results obtained from the LOPCOW method, ITR, ROE and LTD were the most important criteria, while ATR, CAR and ETR were the least important criteria. The results obtained from the CRITIC method demonstrate that STD, ETR and LR were the most important criteria, while CR, LR and CAR were the least important criteria. Based on the results of AWM, ITR, STD and LTD were the most important criteria, while ATR, CAR and ETR were the least important criteria.

The results of the CoCoSo method showed that, MAGEN, ZEDUR and KARYE had the highest financial performances, while PAMEL, AKSEN and ARASE had the lowest financial performances, respectively. Additionally, the sensitivity analysis was applied to monitor the validity of the proposed model. Overall results emphasized that MAGEN, ZEDUR and KARYE had the highest financial performance, while ARASE, AKSEN and PAMEL had the lowest financial performance in 2022, respectively.

The findings of the current study are consistent with those of Mercan & Çetin (2020); Solmaz et. al (2022) who found that AKSEN had the lowest financial performance among energy companies traded in BIST. Besides that, the present finding seems to be consistent with other research (Kavas et al. 2023) which found ZEDUR had the highest financial performance in 2019. Additionally, these results agree with the finding of other studies (Bağcı & Yiğiter, 2019), in which found that AKENR had the lowest financial performance. Overall, it can be concluded that the findings obtained by the current study are consistent with previous research. However, it should be noted that it will not be sufficient to evaluate the financial performance of

energy companies traded on BIST based on only these ratios. Therefore, it necessary to use the other criteria such as number of employees, investment in research and development, company size, etc.

Several limitations to this study need to be acknowledged. The current study has only examined energy companies traded in BIST for the period of one year (2022). Therefore, a further study could assess the long-term financial performance of different sector traded in BIST. For instance, the last five years financial performance of companies which operated in different sector could evaluate using the different MCDM methods such as MEREC, CRADIS, MACONT etc.

REFERENCES

Akbulut, O. Y. (2020). Finansal Performans İle Pay Senedi Getirisi Arasindaki İlişkinin Bütünleşik CRITIC ve MABAC ÇKKV Teknikleriyle Ölçülmesi: Borsa İstanbul Çimento Sektörü Firmalari Üzerine Ampirik Bir Uygulama. Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, (40), 471-488.

Bağcı, H., ve Yüksel Yiğiter, Ş. (2019). BİST'te Yer Alan Enerji Şirketlerinin Finansal Performansının SD ve WASPAS Yöntemleriyle Ölçülmesi. Bingöl Üniversitesi Sosyal Bilimler Enstitüsü Dergisi , 9 (18) , 877-898 .

Bektaş, S. (2022). Türk Sigorta Sektörünün 2002-2021 Dönemi için MEREC, LOPCOW, COCOSO, EDAS ÇKKV Yöntemleri ile Performansının Değerlendirilmesi. BDDK Bankacılık ve Finansal Piyasalar Dergisi, 16(2), 247-283.

Çiftci, H. N., & Yildirim, B. F. (2020). Bist Enerji Sektöründe Faaliyet Gösteren İşletmelerin Finansal Performanslarinin İncelenmesi: Gri Sayilara Dayali Zaman Kesiti Örneği. Muhasebe Bilim Dünyası Dergisi, 22(3), 384-404.

Cooper, S. (2004). Corporate Social Performance: A Stakeholder Approach, 1st Edition, England, Routledge Publishing.

Diakoulaki, D., Mavrotas, G., & Papayannakis, L. (1995). Determining objective weights in multiple criteria problems: The critic method. Computers & Operations Research, 22(7), 763-770.

Dursun, G. D. (2018). Türkiye'de faaliyet gösteren ticari bankaların aktif kalitesinin TOPSIS yöntemi ile ölçümü. Ekonomi Politika ve Finans Araştırmaları Dergisi, 3(3), 243-258.

Ecer, F., & Pamucar, D. (2022). A novel LOPCOW-DOBI multi-criteria sustainability performance assessment methodology: An application in developing country banking sector. Omega, 112, 102690.

Ersoy, N. (2023). BIST Perakende Ticaret Sektöründe LOPCOW-RSMVC Modeli ile Performans Ölçümü. Sosyoekonomi, 31(57), 419-436.

Ertaş, F. C., & Yetim, A. (2022). Covıd-19 pandemisinde gıda ve içecek sektöründeki işletmelerin finansal performansının TOPSIS yöntemiyle incelenmesi: BIST örneği. Muhasebe ve Finansman Dergisi, (93), 53-74.

Gümrah, A. (2016). Measuring the performance of participation banks by TOPSIS method: Turkey and Malaysia cases. International Journal of Business and Management Studies, 5(1), 211-218.

Gürkan, S., & Aldoury, N. (2021). Topsis çok kriterli karar verme yöntemi ile karşilaştirmali finansal performans analizi: teknoloji şirketleri üzerine bir araştirma. Finans Ekonomi ve Sosyal Araştırmalar Dergisi, 6(2), 225-239.

Ighravwe, D., & Babatunde, M. (2018). Selection of a Mini-grid Business Model for Developing Countries Using CRITIC-TOPSIS with Interval Type-2 Fuzzy Sets. Decision Science Letters, 7(4), 427-442. https://doi.org/10.5267/j.dsl.2018.1.004

İskenderoğlu, Ö., Karadeniz, E., & Ayyildiz, N. (2015). Enerji sektörünün finansal analizi: Türkiye ve Avrupa enerji sektörü karşılaştırması. İşletme ve İktisat Çalışmaları Dergisi, 3(3), 86-97.

Kandemir, T., & Karataş, H. (2016). Ticari bankaların finansal performanslarının çok kriterli karar verme yöntemleri ile incelenmesi: Borsa İstanbul'da işlem gören bankalar üzerine bir uygulama (2004-2014). İnsan ve Toplum Bilimleri Araştırmaları Dergisi, 5(7), 1766-1776.

Karaoğlan, S., & Şahin, S. (2018). BİST XKMYA işletmelerinin finansal performanslarının çok kriterli karar verme yöntemleri ile ölçümü ve yöntemlerin karşılaştırılması. Ege akademik bakış, 18(1), 63-80.

Kavas, Y. B., Medetoğlu, B., & Öztürk, M. (2023). Finansal performans analizi: TOPSIS ve MOORA yöntemleriyle BIST elektrik gaz ve buhar sektörü üzerine bir uygulama. EKEV Akademi Dergisi, (94), 330-344.

Kınalı, F. (2022). İşletmelerin Finansal Performanslarının Mali Yapı Oranları Açısından Değerlendirilmesi. Selçuk Üniversitesi Sosyal Bilimler Meslek Yüksekokulu Dergisi, 25(2), 746-756.

Konak, T., Elbir, G., Yılmaz, S., Karataş, B., Durman, Y., & Düzakin, H. (2018). Borsa İstanbul'da işlem gören tekstil firmalarının TOPSIS ve MOORA yöntemi ile analizi. Çukurova Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 22(1), 11-44.

KPMG. (2022). Sektörel Enerji Bakış https://kpmg.com/tr/tr/home/gorusler/2022/04/enerji-sektorel-bakis.html (28.11.2023)

Kurt, G., & Kablan, A. (2022). Covid-19'un, BİST ulaştırma endeksinde faaliyet gösteren havayolu işletmelerinin finansal performansı üzerindeki etkilerinin, çok kriterli karar verme yöntemleri ile analizi. İşletme Akademisi Dergisi, 3(1), 16-33.

Maliene, V., Dixon-Gough, R., & Malys, N. (2018). Dispersion of relative importance values contributes to the ranking uncertainty: Sensitivity analysis of Multiple Criteria Decision-Making methods. Applied Soft Computing, 67, 286-298.

Marjanović, I., & Popović, Ž. (2020). MCDM approach for assessment of financial performance of Serbian banks. Business Performance and Financial Institutions in Europe: Business Models and Value Creation Across European Industries, 71-90.

Martin, R. (1997). Do we practise quality principles in the performance measurement of critical success factors?. Total Quality Management, 8(6), 429-444.

Mercan, Y., & Çetin, O. (2020). COPRAS ve VIKOR yöntemleri ile BIST elektrik endeksindeki firmalarinin finansal performans analizi. Uluslararası Afro-Avrasya Araştırmaları Dergisi, 5(9), 123-139.

Moghimi, R., & Anvari, A. (2014). An integrated fuzzy MCDM approach and analysis to evaluate the financial performance of Iranian cement companies. The International Journal of Advanced Manufacturing Technology, 71(1-4), 685-698.

Nguyen, P. H., Tsai, J. F., Hu, Y. C., & Ajay Kumar, G. V. (2022). A Hybrid method of MCDM for evaluating financial performance of Vietnamese commercial banks under COVID-19 impacts. Shifting Economic, Financial and Banking Paradigm: New Systems to Encounter COVID-19, 23-45.

Orhan, M., Altın, H., & Aytekin, M. (2020). Çok kriterli karar verme yöntemleriyle finansal performans değerlendirme: ulaştırma alanında bir uygulama. Turkish Studies - Economy, 15(1), 395-410. https://doi.org/10.29228/TurkishStudies.40149

Özbek, H. E., & Özekenci, E. K. (2023). Investigation of Digital Logistics Market Performance in Developing Countries with Hybrid MCDM Methods. JOEEP: Journal of Emerging Economies and Policy, 8(2), 559-576.

Özekenci, E. K. (2023a). Assessing The Logistics Market Performance of Developing Countries By SWARA-CRITIC Based CoCoSo Method. LogForum, 19(3), 375-394.

Özekenci, E. K. (2023b). Analysis of metropolitan cities export performance in Turkey by integrated MCDM methods. Dicle Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, (34), 89-118.

Safaei Ghadikolaei, A., Khalili Esbouei, S., & Antucheviciene, J. (2014). Applying fuzzy MCDM for financial performance evaluation of Iranian companies. Technological and Economic Development of Economy, 20(2), 274-291.

Şahin, İ. E., & Karacan, K. B. (2019). BIST'te işlem gören inşaat işletmelerinin çok kriterli karar verme yöntemleri ile finansal performans ölçümü. International Journal of Multidisciplinary Studies and Innovative Technologies, 3(2), 162-172.

Say, S., (2022). ARAS ve COPRAS Yöntemleri ile BIST Teknoloji Endeksindeki Şirketlerin Finansal Performans Analizi. Selçuk Üniversitesi Sosyal Bilimler Meslek Yüksekokulu Dergisi, 25(Özel Sayı), 511-523.

Şimşek, O. (2022). Hibrid Bir ÇKKV Modeli ile Türk Bankacılık Sektöründe Finansal Performans Değerlendirmesi. Turkish Studies-Economics, Finance, Politics, 17(2).

Sonmez, F., Baysal, G., Anik Baysal, I., Bademcioglu, M., (2023). Determining the financial performances of BIST100 energy companies by topsis method. PressAcademia Procedia (PAP), 16, 149-155.

Soy Temür, A., & Tulum, S. (2022). BİST Teknoloji İşletmelerinin Nakit Akış Oranlarına Dayalı CRITIC Ağırlıklandırmalı CoCoSo Yöntemi ile Finansal Performans Analizi. Pamukkale University Journal of Social Sciences Institute/Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, (51).

Süslü, C., & Hizlier, S. S. (2023). CRITIC tabanlı MULTIMOORA ve TOPSIS yöntemleri ile finansal performans analizi: BIST spor endeksi şirketleri üzerine bir çalışma. İşletme, 4(1), 109-129.

Topal, A. (2021). Çok kriterli karar verme analizi ile elektrik üretim şirketlerinin finansal performans analizi: Entropi tabanlı Cocoso yöntemi. Business & Management Studies: An International Journal, 9(2), 532-546.

Yazdani, M., Zarate, P., Kazimieras Zavadskas, E., & Turskis, Z. (2019). A combined compromise solution (CoCoSo) method for multi-criteria decision-making problems. Management decision, 57(9), 2501-2519.