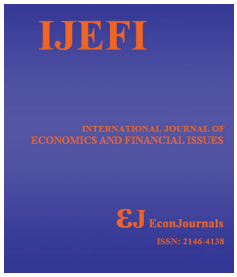

International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2024, 14(6), 379-391.

Financial Performance Analysis of Energy Companies Using Multi-Criteria Decision-Making Techniques: An Application in the BIST Electricity, Gas and Water Sector

Azize Kahramani Koc*, Alper Tazegul, Savas Durmus

Department of International Trade and Logistics, Faculty of Economics and Administrative Sciences, Kafkas University, Kars, Turkey. *Email: azizekahramani@gmail.com

Received: 19 August 2024 **Accepted:** 25 October 2024 **DOI:** https://doi.org/10.32479/ijefi.17609

ABSTRACT

Energy plays a vital role in the macroeconomic development of countries. The increase in energy consumption and the increase in the number of energy companies are among the basic dynamics of country development and growth. Enhancing the financial performance of companies operating in the energy sector strengthens the competitive power of countries at both national and international levels. In this context, this study aims to determine the financial performance rankings of companies operating in the energy sector in Turkey over a 10-year period, identifying the most successful and least successful periods over the years. Using data from energy sector companies listed on Borsa Istanbul (BIST) between 2013 and 2022, after determining the research criteria, the weights of these criteria were calculated using the Entropy method. Subsequently, considering the criteria weights, the performance rankings of energy companies were determined year by year using the MAIRCA method. According to the results of the Entropy analysis, when the importance level is evaluated, the most significant criterion in 2013 was the Liquidity Ratio (LR), in 2014, 2017, 2018, and 2019 it was the Gross Profit Growth (GPG) criterion, in 2015 it was the Current Ratio (CR) criterion, in 2016 and 2022 it was the Net Profit Growth (NPG) criterion, and in 2020 it was the Net Profit Growth (NPG) criterion. Finally, in 2021, the most important criterion was determined to be EBITDA Growth (EBG). Furthermore, based on the MAIRCA analysis, the reasons behind the most successful and least successful years of the companies were explained using financial and activity reports, as well as special situation disclosure notifications obtained from the Public Disclosure Platform (PDP).

Keywords: Energy Sector, Financial Performance, Multi-criteria Decision-making Methods, Türkiye
JEL Classifications: K32, L25, C58

1. INTRODUCTION

Today, when the negative effects of climate change affect the entire world, the energy sector has become a critical element of the global economy. This process has resulted in the energy sector becoming a more complex structure, rather than just an important component of economic life. The energy sector has been continuing this transformation process uninterruptedly from the Industrial Revolution to the present day. Environmental challenges, energy security problems and global fluctuations that have become more apparent, especially in the last half-century, have made the energy sector more noticeable. The energy sector, which determines the growth of national economies and affects various industries (Ntanos et al., 2018), is also considered an indicator of the level of economic development of countries (Edenhofer et al., 2011). In this context, the energy sector emerges as a multidimensional phenomenon that needs to be addressed from financial, fiscal, social, developmental and environmental perspectives (Katsamppoxakis et al., 2022). Environmental challenges that have become more evident in the globalizing world

in recent years have made sustainable growth policies necessary. An important component of sustainable growth is the concept of sustainable energy.

Sustainable energy refers to energy production models that can meet the current and future needs of countries with the lowest economic, environmental and social costs (Randolph and Masters, 2008). These models provide long-term economic benefits by increasing energy efficiency and reducing emissions from energy production (Tan et al., 2017). However, energy production and consumption are increasing rapidly, which leads to ecosystem degradation and serious environmental problems. These problems force countries and companies to take measures to make energy resources clean and sustainable and to reduce environmental pollution (Ersoy and Taslak, 2023). At this point, companies operating in the energy sector have great responsibilities.

As in other sectors, the primary goal of companies in the energy sector is to demonstrate good financial performance and make profits by using their resources efficiently. The financial performance of companies is considered an important indicator of whether their financial situation is good or bad (Purba and Bimantara, 2020). In particular, companies with a corporate structure and sustainable environmental policies are more likely to achieve their goals. The energy sector has a high risk level and a strong financial infrastructure is needed for the sustainability of production. In order to reduce these risks, financial performance measurements are made in the energy sector, and these measurements provide effective results in future performance estimates (Yaşar and Terzioğlu, 2022). In this study, financial performance measurement in the energy sector, whose importance is increasing day by day, was evaluated specifically for energy sector companies traded on Borsa Istanbul (BIST). In the study, the performances of the companies were analyzed using multi-criteria decision-making methods. In the analysis conducted with 10-year data, the criteria weights were determined with the Entropy method, and then, considering these weights, the performance rankings of the companies by year were calculated with the MAIRCA method.

2. LITERATURE REVIEW

In the study conducted by Sakarya et al. (2015), the financial performances of 14 energy companies registered in BIST between 2010 and 2014 were analyzed using the TOPSIS method. According to the analysis results, the most successful and least successful companies in terms of financial performance in the 5-year period were determined.

In the study conducted by Metin et al. (2017), the financial performances of 11 energy companies registered in BIST between 2010 and 2015 were evaluated using the TOPSIS and MOORA methods. According to the study findings, it was determined that the rankings obtained in both methods were different.

In their study, Eyüboglu and Ve Çelik (2016) aimed to calculate the financial performances of Turkish energy companies in the period 2008-2013. Fuzzy AHP and Fuzzy TOPSIS methods were used as methods, and analysis was carried out with 15 evaluation criteria. As a result of the analysis, the company with the highest financial performance was determined as AVTUR, and the company with the lowest performance was determined as ZOREN.

Karakul and Özaydın (2019) analyzed the financial performances of 8 companies traded in the BIST energy sector in 2017 using TOPSIS and VIKOR methods. Financial performance rankings were obtained in both methods.

In the study conducted by Mercan and Çetin (2019), the financial performances of 7 companies included in the BIST electricity index between 2014 and 2018 were analyzed using COPRAS and VIKOR methods. The results showed that the company rankings were the same in both methods.

In the study by Orçun (2019), the financial performances of 5 companies in the BIST Electricity Index were analyzed using Entropy and WASPAS methods. In addition, the relationship between the obtained financial performance rankings and stock market returns was examined with Spearman rank correlation. The findings revealed that AYEN was the most successful company in 2016 and 2017. However, no significant relationship was found between financial performance rankings and stock market returns.

In the study by Arsu (2021), the financial performances of the companies in the Electricity, Gas and Steam Sector traded in BIST were calculated using the Entropy-based ARAS method using 2018 data. According to the analysis results, the most successful company was determined as ENJSA, while the least successful company was determined as BMELK.

Çiftçi and Yıldırım (2020) examined the financial performances of 6 companies traded in the BIST Energy sector between 2011 and 2019 using Gray Relational Analysis and Gray Entropy methods. According to the analysis results, the most ideal company within the framework of 20 financial ratio criteria was determined as Aksa Energy, while the farthest from ideal company was determined as Zorlu Energy.

In the study by Karcıoğlu et al. (2020), the financial performances of 8 energy companies registered in BIST between 2013 and 2017 were evaluated using Intuitive Fuzzy Logic and Entropy-Based Multi-Criteria Decision Making techniques. In the 5-year average, the company with the best performance was ODAS, and the company with the worst performance was AYEN.

In the study by Topal (2021), the financial performance of 10 energy companies in the Fortune 500 in 2019 was analyzed using the Entropy and Cocoso methods. According to the results, the most successful company was ENKA, and the least successful company was GAMA ENERJİ.

In the study by Akgün (2022), the financial performances of 12 energy companies traded on BIST in 2020 and 2021 were analyzed using the CRITIC and CODAS methods. With the CODAS method, the most successful company in 2020 was determined as NTGAZ, and the least successful company was determined as

HUNER. For 2021, the most successful company was determined as ARASE, and the least successful company was determined as BIOEN.

In the study conducted by Babacan and Tuncay (2022), the interaction between the financial performances and working capital of 8 companies operating in the BIST energy sector between 2014 and 2020 was examined. The analyses conducted using the AHP, SWARA and TOPSIS methods showed that the company rankings may differ according to the methods.

Terzioğlu et al. (2022) evaluated the financial performances of 8 companies operating in the BIST Electricity, Steam and Gas sector with the SWARA method, and then created performance rankings with the WASPAS and VIKOR methods. The results revealed that the financial performance rankings differed according to both methods.

In the study of Özdemir and Parmaksız (2022), the financial performances of 16 companies in the BIST energy sector were analyzed using the TOPSIS and EDAS methods. The findings showed that the most successful and least successful companies were the same according to both methods in 2019 and 2020.

Bektaş (2023) evaluated the financial performances of energy companies traded in BIST 100 in 2022 using MEREC and MABAC methods. According to the results, the company with the most successful financial performance was determined as ENJSA, while the least successful company was determined as BIOEN.

In the study by Medetoğlu et al. (2023), the financial performances of 8 companies operating in the BIST Electricity, Gas and Steam sector between 2017 and 2021 were analyzed using TOPSIS and MOORA methods. The results revealed that there were significant similarities between the two methods, but the rankings changed due to calculation differences.

In the study conducted by Makki and Alqahtani (2023), the financial performances of companies in the Saudi energy sector between 2019 and 2021, before and after COVID-19, were examined. AHP and TOPSIS methods were used by following a hybrid Multi-Criteria Decision Making approach, and the impact of COVID-19 on the performances of energy companies was analyzed.

In the study conducted by Sönmez et al. (2023), the financial performances of 5 energy companies listed in BIST 100 in 2021 were evaluated with the TOPSIS method. The results showed that the most successful company was IPEKE and the least successful company was VESTL.

In the study of Yalçın and Ersoy (2024), it was aimed to examine the financial performances of energy companies registered in BIST in the 2020-2022 period using the cash flow ratio evaluation criterion with Entropy and TOPSIS methods. The results revealed that there were different performance rankings according to liquidity power and cash management on a yearly basis.

3. METHODOLOGY

In this study, the financial performance of companies operating in the Electricity, Gas and Water sector on BIST was analyzed using Multi-Criteria Decision-Making (MCDM) methods. The aim was to identify the years in which companies demonstrated their most successful and least successful financial performance. The weights of the criteria were determined using the Entropy method. Subsequently, the performance rankings of energy companies were calculated year by year using the MAIRCA method, considering the weights of the criteria.

3.1. Entropy Method

Entropy was first defined by Rudolph Clausius in 1865 as a measure of disorder within a system (Zhang et al., 2011). The Entropy method calculates the relative weight of each criterion using relatively simple calculations without requiring an individual decision-maker to rank the criteria (Erol and Ferrell, 2009). This ensures the objectivity of the method and provides it with a significant advantage. The codes for the variables used in the Entropy Method are shown below (Ayçin, 2020):

A_i=i decision alternative (= 1,2,….,m)

C_j=j evaluation criterion (j = 1,2,….,n)

X_{ij}=j the value of the i. alternative according to the j. evaluation criterion

P_{ij}=normalized value of the i. alternative according to the j. evaluation criterion

k=entropy coefficient

e_j=entropy value

d_j=degree of diversification

w_j=weight of the j. evaluation criterion (j = 1,2,….,n)

The Entropy Method consists of five stages (Lam et al., 2021; Yufang and Wanli, 2021):

Decision matrix

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{bmatrix} & & & \\ x_{11} & x_{12} \dots & x_{1n} \\ x_{21} & x_{22} \dots & x_{2n} \\ \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & x_{mn} \end{bmatrix} \quad (1)$$

Normalization

$$P_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}}}; \forall_{i,j} \quad (2)$$

Entropy values

$$e_{ij} = -k\sum_{j=1}^{n} P_{ij}.\ ln(P_{ij}); i = 1,2,\ldots,m\ ve\ j = 1,2,\ldots,n \quad (3)$$

The k value in Formula 3:

$k = (\ln(m))^{-1}$ is a constant coefficient that takes a value such that $0 \leq e_j \leq 1$

Degrees of Differentiation

$$d_j = 1\text{-}e_j \qquad (j = 1,2...,n) \quad (4)$$

Calculating entropy criterion weights

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \quad (5)$$

In the Entropy method, the presence of negative values in the decision matrix can cause issues in calculations. In such cases, various correction methods found in the literature are applied. Using the Z-score standardization transformation developed by Zhang et al. (2014), negative values in the decision matrix are transformed using Formula 6 (Zhang et al., 2014; Ayçin, 2020).

$$Z_{ij} = \frac{X_{ij} - \bar{X}_j}{\sigma_j} \quad (6)$$

Subsequently, the data in the decision matrix are converted to positive values using Formula 7.

$$z'_{ij} = z_{ij} + A; A > \left| min\ z_{ij} \right| \quad (7)$$

3.2. MAIRCA Method

The MAIRCA method, defined by Pamucar et al. in 2014 (Ayçin, 2020), is based on the fundamental assumption of determining the gap between ideal and empirical weights. By summing these gaps for each criterion, the MAIRCA method creates an overall gap to evaluate the alternatives under consideration. In the final stage of the method, the alternative with the smallest total gap is considered the best choice, representing the most ideal option. MAIRCA is an effective method that accounts for the concepts of positive and negative ideal solutions. The steps of the MAIRCA method are outlined below (Gigovic et al., 2016; Pamucar et al., 2018; Chatterjee et al., 2018).

- Step 1: Construct the decision matrix.

$$X = \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix}\begin{bmatrix} x_{11} & x_{12}\ldots & x_{1n} \\ x_{21} & x_{22}\ldots & x_{2n} \\ \vdots & \vdots & \vdots \\ x_{m1} & x_{m2}\ldots & x_{mn} \end{bmatrix} X= \quad (8)$$

- Step 2: Determine the priorities of the alternatives.

$$P_{Ai} = \frac{1}{m} \quad (9)$$

$$\sum_{i=1}^{m} P_{Ai} = 1i = 1,2,\ldots,m \quad (10)$$

$$P_{A1} = P_{A2} = \cdots = P_{Am} \quad (11)$$

- Step 3: Construct the theoretical rating matrix.

$$T_p = \begin{bmatrix} P_{A1}w_1 & P_{A1}w_2\ldots & P_{A1}w_n \\ P_{A2}w_1 & P_{A2}w_2\ldots & P_{A2}w_n \\ \vdots & \vdots & \vdots \\ P_{Am}w_1 & P_{Am}w_2 & P_{Am}w_n \end{bmatrix} \quad (12)$$

- Step 4: Construct the empirical rating matrix.
  - For a benefit-type criterion (where a higher value is preferable):

$$t_{rij} = t_{pij}\cdot\left(\frac{x_{ij} - x_{ij}^{-}}{x_{ij}^{+} - x_{ij}^{-}}\right) \quad (13)$$

  - For a cost-type criterion (where a lower value is preferable):

$$t_{rij} = t_{pij}\cdot\left(\frac{x_{ij} - x_{ij}^{+}}{x_{ij}^{-} - x_{ij}^{+}}\right) \quad (14)$$

Here, x_{ij}^{+} represents the maximum value obtained by the criterion for an alternative, and x_{ij}^{-} represents the minimum value.

$$T_r = \begin{bmatrix} t_{r11} & t_{r12}\ldots & t_{r1n} \\ t_{r21} & t_{r22}\ldots & t_{r2n} \\ \vdots & \vdots & \vdots \\ t_{rm1} & t_{rm2} & t_{rmn} \end{bmatrix} \quad (15)$$

- Step 5: Construct the total gap matrix.

$$g_{ij} = t_{pij} - t_{rij}\ g_{ij}\ \varepsilon[0,\infty] \quad (16)$$

$$T_p - T_r = \begin{bmatrix} g_{11} & g_{12}\ldots & g_{1n} \\ g_{21} & g_{22}\ldots & g_{2n} \\ \vdots & \vdots & \vdots \\ g_{m1} & g_{m2} & g_{mn} \end{bmatrix} \quad (17)$$

- Step 6: Define the total gap for each alternative.

As a result of the calculations, if the actual rating (t_{rij}) of an alternative (A_i) and theoretical rating (t_{pij}) for a criterion (C_j) is a non-zero value and matches, the gap ($g_{ij} = 0$) will be zero. In this context, the alternative (A_i) is considered the ideal alternative (A_i^{+}) for the criterion (C_i). However, if both the actual rating (t_{rij}) and

theoretical rating (t_{pij}) of an alternative (A_i) for a criterion (C_j) are zero, the gap value ($t_{pij} = t_{rij} = g_{ij} = 0$) will also be zero. Consequently, the alternative (A_i) is considered the worst alternative (A_i^-) for criterion (C_j) (Ayçin, 2020: 192).

- Step 7: Calculate the Final Criterion Function Value for the Alternatives.

The final values of the criterion functions (Q_i) are obtained by summing the alternatives and gaps (g_{ij}).

$$Q_i = \sum_{j=1}^{n} g_{ij}, i = 1,2,\ldots,m \quad (18)$$

3.3. Sample and data collection

The research covers the data from 2013 to 2022 for 6 companies selected according to research criteria among the 32 companies operating in the Electricity, Gas, and Water sector BIST. A total of 32 companies operate in the Electricity, Gas, and Steam sector. However, most of these companies were listed on the BIST in 2020 or later, so they were excluded from the scope of the research. The names and codes of the companies analyzed in the Electricity, Gas, and Water sector are presented in Table 1.

The ratios used in the research were obtained from Finnet Analysis Expert. Table 2 provides the evaluation criteria and their codes. The findings of the research are limited to the applied methodology, the selected financial ratios and the years evaluated.

Table 1: The sample of the research

Code	Company title
AKENR	Akenerji Elektrik Üretim A.Ş.
AKSEN	Aksa Enerji Üretim A.Ş.
AKSUE	Aksu Enerji ve Ticaret A.Ş.
AYEN	Ayen Enerji A.Ş.
ODAS	Odaş Elektrik Üretim Sanayi Ticaret A.Ş.
ZOREN	Zorlu Enerji Elektrik Üretim A.Ş.

Table 2: Evaluation criteria

Code	Evaluation criteria	Purpose
EBM	EBITDA margin	Maximum (Benefit)
GP	Gross profit	Maximum (Benefit)
NP	Net profit	Maximum (Benefit)
NPG	Net profit growth	Maximum (Benefit)
GPG	Gross profit growth	Maximum (Benefit)
EBG	EBITDA growth	Maximum (Benefit)
CR	Current ratio	Maximum (Benefit)
LR	Liquidity ratio	Maximum (Benefit)
PTC	Permanent turnover of capital	Maximum (Benefit)
ATR	Asset turnover ratio	Maximum (Benefit)

4. RESULTS

In this research, the data of 6 companies in the Electricity, Gas and Water Sector traded in BIST were obtained from Finnet and analyzed using 10 evaluation criteria. In the analysis, using the Excel program, the importance weight degrees of the criteria were obtained by ranking from the most important criterion to the least important criterion by using the Entropy method from Multi-Criteria Decision-Making Methods. Then, MAIRCA method was used to determine which company is the most successful and which company is the least successful in terms of financial performance year by year.

4.1. Entropy Analysis Results

In order to obtain the decision matrix of 6 companies in the Electricity, Gas and Water Sector for the year 2013, the mean and standard deviation of the negative values were calculated and presented in Table 3.

The negative values in Table 3 were transformed with the help of formula 6, the Z-score standardization formula developed by Zhang et al. (2014), and presented in Table 4.

The values in Table 4 for 2013 were converted to positive values using formula 7 and presented in Table 5.

The decision matrix for 2013 was calculated through formula 1 and presented in Table 6.

Normalized decision matrix was created through formula 2 and presented in Table 7.

Entropy values for the criteria were obtained through formula 3 and these values are given in Table 8.

Degrees of differentiation were calculated using formula 4 and presented in Table 9.

Entropy criterion weights importance degree was calculated using formula 5 and presented in Table 10.

When Table 10 is examined, the criterion with the highest degree of importance among the criteria used in the analysis of the companies in the Electricity, Gas and Water Sector for 2013 was determined as LR criterion with a value of 0.2064, while the criterion with the lowest degree of importance was determined as ATR criterion with a value of 0.0127.

Table 3: Means and standard deviations for 2013

Companies/Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
AKENR	21.50	−16.48	19.38	−256.67	7.80	99.25	1.04	0.96	0.27	10.01
AKSEN	17.46	−7.37	12.32	−157.70	−7.00	322.83	0.83	0.36	0.79	7.87
AKSUE	46.82	−96.46	46.24	−131.20	−38.63	−152.95	7.54	7.37	0.06	12.59
AYEN	20.71	−13.24	16.15	−322.38	10.03	450.01	0.62	0.45	0.45	8.24
ODAS	7.88	−1.18	8.37	−146.10	66.61	426.46	1.14	0.88	3.04	16.80
ZOREN	18.06	−49.47	2.32	−152.52	205.67	−37.1	0.32	0.29	0.13	7.30
Ort.	–	−30.6993	-	−194.4283	40.7467	184.7500	-	-	-	-
Stdandard deviation	-	36.3290	-	77.0511	87.7236	252.3575	-	-	-	-

Table 4: Adjusted Criterion Values for 2013

Companies/Criteria	NP Z_{ij}	NPG Z_{ij}	GPG Z_{ij}	EBG Z_{ij}
AKENR	0.39	−0.81	−0.38	−0.34
AKSEN	0.64	0.48	−0.54	0.55
AKSUE	−1.84	0.82	−0.90	−1.34
AYEN	0.48	−1.66	−0.35	1.05
ODAS	0.81	0.63	0.29	0.96
ZOREN	−0.52	0.54	1.88	−0.88

Table 5: Converting negative values to positive values for 2013

Companies/criteria	NP z'_{ij}	NPG z'_{ij}	GPG z'_{ij}	EBG z'_{ij}
AKENR	2.21	0.86	0.53	1.01
AKSEN	2.46	2.15	0.37	1.9
AKSUE	0.01	2.49	0.01	0.01
AYEN	2.30	0.01	0.56	2.4
ODAS	2.63	2.30	1.20	2.31
ZOREN	1.30	2.21	2.79	0.47

In 2013, all steps for the Entropy method were performed for the years 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021 and 2022. Due to the high number of analysis steps and page limitations, the decision matrix of each year and the importance levels of the criteria weights (w_j) are included in the study.

The decision matrix for 2014 was calculated through formula 1 and presented in Table 11.

When Table 12 is examined, the criterion with the highest degree of importance for 2014 is determined as GPW criterion with a value of 0.1715, while the criterion with the lowest degree of importance is determined as ATR criterion with a value of 0.0319.

The decision matrix for 2015 was calculated through formula 1 and presented in Table 13.

Table 14 shows that the most important criterion in 2015 was CO with a value of 0.1638, while the least important criterion was GP with a value of 0.0377.

Table 6: Corrected decision matrix for 2013

Criterion aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	21.50	2.21	19.38	0.86	0.53	1.01	1.04	0.96	0.27	10.01
AKSEN	17.46	2.46	12.32	2.15	0.37	1.9	0.83	0.36	0.79	7.87
AKSUE	46.82	0.01	46.24	2.49	0.01	0.01	7.54	7.37	0.06	12.59
AYEN	20.71	2.30	16.15	0.01	0.56	2.4	0.62	0.45	0.45	8.24
ODAS	7.88	2.63	8.37	2.30	1.20	2.31	1.14	0.88	3.04	16.80
ZOREN	18.06	1.30	2.32	2.21	2.79	0.47	0.32	0.29	0.13	7.30

Table 7: Normalized decision matrix for 2013

Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	0.1623	0.2026	0.1850	0.0858	0.0971	0.1247	0.0907	0.0928	0.0575	0.1594
AKSEN	0.1319	0.2255	0.1176	0.2146	0.0678	0.2346	0.0718	0.0351	0.1672	0.1253
AKSUE	0.3535	0.0009	0.4413	0.2485	0.0018	0.0012	0.6563	0.7151	0,0118	0.2004
AYEN	0.1564	0.2108	0.1541	0.0010	0.1026	0.2963	0.0544	0.0435	0.0953	0.1312
ODAS	0.0595	0.2411	0.0799	0.2295	0.2198	0.2852	0.0989	0.0854	0.6399	0.2675
ZOREN	0.1364	0.1192	0.0221	0.2206	0.5110	0.0580	0.0279	0.0282	0.0284	0.1163

Table 8: Entropy values relating to criteria in 2013

Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	−0.2951	−0.3234	−0.3121	−0.2107	−0.2264	−0.2596	−0.2177	−0.2206	−0.1643	−0.2927
AKSEN	−0.2671	−0.3359	−0.2517	−0.3302	−0.1824	−0.3401	−0.1891	−0.1175	−0.2990	−0.2602
AKSUE	−0.3676	−0.0064	−0.3610	−0.3460	−0.0115	−0.0083	−0.2764	−0.2398	−0.0525	−0.3221
AYEN	−0.2902	−0.3282	−0.2882	−0.0069	−0.2336	−0.3604	−0.1583	−0.1364	−0.2240	−0.2664
ODAS	−0.1679	−0.3430	−0.2018	−0.3378	−0.3330	−0.3578	−0.2288	−0.2101	−0.2857	−0.3527
ZOREN	−0.2717	−0.2535	−0.0844	−0.3334	−0.3431	−0.1652	−0.1000	−0.1005	−0.1011	−0.2502
ln (m)	0.5581									
e_j	0.9263	0.8876	0.8367	0.8735	0.7423	0.8324	0.6531	0.5720	0.6287	0.9736

Table 9: Degrees of Differentiation in 2013

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
d_j	0.0737	0.1124	0.1633	0.1265	0.2577	0.1676	0.3469	0.4280	0.3713	0.0264

Table 10: Entropy criteria weights in 2013 ımportance degree

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
wj	0.0356	0.0542	0.0787	0.0610	0.1243	0.0808	0.1673	0.2064	0.1790	0.0127

Table 11: Corrected decision matrix for 2014

Criterion Aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	CRTD NP	CRTD GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	4.11	1.40	0.01	3.04	0.01	2.28	0.50	0.40	0.43	10.32
AKSEN	17.57	2.37	1.55	1.69	0.58	2.53	0.51	0.20	0.79	21.44
AKSUE	17.40	0.01	2.18	2.07	0.17	2.43	4.42	4.28	0.04	7.40
AYEN	33.34	2.68	2.97	1.57	0.51	2.46	0.82	0.73	0.21	7.30
ODAS	8.64	2.45	1.14	0.01	0.58	2.54	0.80	0.63	2.57	17.29
ZOREN	23.03	1.42	1.27	2.18	2.75	0.01	0.31	0.29	0.27	6.68

Table 12: Entropy criteria weights ımportance level for 2014

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
w_j	0.0470	0.0625	0.0710	0.0603	0.1715	0.0523	0.1472	0.1852	0.1712	0.0319

Table 13: Corrected decision matrix for 2015

Criterion Aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	14.17	0.67	8.84	2.69	0.01	0.01	2.52	2.38	0.36	13.00
AKSEN	19.54	1.05	14.44	0.01	2.39	2.42	0.54	0.21	0.86	27.25
AKSUE	33.82	2.99	28.15	1.74	2.67	1.31	4.07	3.78	0.07	9.97
AYEN	26.61	1.02	20.34	1.84	2.34	2.35	0.44	0.43	0.24	9.60
ODAS	7.89	1.40	8.84	2.22	2.30	2.08	0.90	0.66	1.13	10.59
ZOREN	36.69	0.01	22.91	2.72	2.48	2.69	0.39	0.38	0.20	8.75

Table 14: Entropy criteria weights ımportance level for 2015

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
w_j	0.0453	0.1340	0.0377	0.0819	0.0755	0.0856	0.1638	0.1975	0.1370	0.0417

Table 15: Corrected decision matrix for 2016

Criterion aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	11.07	0.01	3.11	0.79	0.01	0.01	1.11	1.05	0.32	13.09
AKSEN	13.57	1.65	8.72	0.83	0.92	0.37	0.71	0.27	1.54	11.51
AKSUE	46.72	0.28	48.67	0.01	2.47	0.59	0.23	0.16	0.06	10.23
AYEN	35.06	1.86	28.56	0.59	2.40	2.27	0.36	0.35	0.26	11.78
ODAS	11.89	2.23	12.81	2.83	2.08	1.84	0.91	0.57	0.80	8.46
ZOREN	33.77	2.32	21.95	0.29	2.25	2.19	0.47	0.42	0.28	6.94

Table 16: Entropy criteria weights ımportance level for 2016

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
w_j	0.0614	0.1245	0.1079	0.1909	0.0904	0.1441	0.0493	0.0695	0.1534	0.0086

Table 17: Corrected decision matrix for 2017

Criterion Aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	9.77	1.91	2.89	1.86	0.46	0.52	0.28	0.25	0.35	22.09
AKSEN	13.45	2.53	8.76	1.57	0.38	2.83	0.69	0.42	1.20	7.54
AKSUE	27.13	0.01	21.07	2.90	0.01	0.01	0.23	0.18	0.12	5.99
AYEN	22.94	2.48	18.91	1.54	0.09	1.34	0.72	0.51	0.30	13.88
ODAS	8.89	2.63	10.19	0.01	0.15	1	0.63	0.42	0.56	7.53
ZOREN	18.92	2.37	16.62	0.64	2.63	1.85	0.51	0.43	0.70	12.51

Table 18: Entropy criteria weights ımportance level for 2017

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
w_j	0.0360	0.0815	0.0604	0.1202	0.3657	0.1390	0.0344	0.0238	0.0924	0.0466

Table 19: Corrected decision matrix for 2018

Criterion Aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	11.63	0.21	2.60	2.86	0.16	1.94	0.22	0.15	0.52	14.26
AKSEN	22.70	2.21	15.75	1.39	1.24	1.76	0.86	0.68	1.36	3.35
AKSUE	73.69	0.01	58.57	1.62	2.79	0.01	0.38	0.32	0.17	5.99
AYEN	27.69	2.01	21.87	0.41	0.86	2.21	0.57	0.36	0.39	13.25
ODAS	7.56	1.39	6.31	0.01	0.01	2.67	0.38	0.16	0.42	9.24
ZOREN	28.98	2.21	24.89	1.26	0.77	2.76	0.56	0.42	0.54	10.11

Table 20: Entropy criteria weights ımportance level for 2018

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
w_j	0.1052	0.1390	0.1420	0.1340	0.1907	0.0812	0.0349	0.0547	0.0798	0.0385

Table 21: Corrected decision matrix for 2019

Criterion aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	20.47	0.01	9.75	2.42	2.16	0.01	0.52	0.41	0.28	18.54
AKSEN	25.16	2.25	18.20	2.64	0.44	1.81	0.91	0.78	1.07	2.83
AKSUE	74.20	2.76	65.43	2.36	0.42	1.79	0.70	0.66	0.19	5.72
AYEN	47.91	2.16	38.39	2.35	0.21	1.51	0.40	0.18	0.24	12.57
ODAS	24.29	1.00	18.77	2.45	2.21	3.15	0.45	0.19	0.46	7.06
ZOREN	20.73	1.89	17.38	0.01	0.01	1.57	0.51	0.42	0.79	10.03

Table 22: Entropy criteria weights ımportance level for 2019

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
w_j	0.0686	0.1116	0.1013	0.0895	0.2623	0.1098	0.0211	0.0659	0.0964	0.0735

Table 23: Corrected decision matrix for 2020

Criterion Aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR
AKENR	19.29	0.26	9.06	2.22	1.13	32.53	0.60	0.56	0.36	21.64
AKSEN	21.25	2.45	16.56	2.13	1.60	10.34	1.05	0.99	1.25	2.85
AKSUE	71.83	0.01	65.60	0.25	2.16	35.76	0.19	0.17	0.26	4.98
AYEN	43.65	1.57	33.33	0.01	0.01	14.25	0.34	0.32	0.21	13.10
ODAS	29.29	1.21	24.31	2.11	2.81	35.91	0.47	0.23	0.42	6.33
ZOREN	21.18	2.23	17.68	1.61	0.76	19.51	0.50	0.47	0.63	7.01

Table 24: Entropy criteria weights ımportance Level for 2020

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
w_j	0.0641	0.1640	0.0967	0.1539	0.1330	0.0469	0.0605	0.0813	0.0960	0.1038

Table 25: Corrected decision matrix for 2021

Criterion aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	GPG	EBG	CR	LR	PTC	ATR
AKENR	19.51	2.34	15.34	2.32	203.00	348.18	0.96	0.94	0.34	19.37
AKSEN	17.81	2.62	14.97	2.66	73.58	100	1.14	1.07	1.03	3.73
AKSUE	60.44	0.01	68.38	2.32	24.16	22.4	0.49	0.46	0.31	4.89
AYEN	41.56	2.51	36.03	1.03	199.66	168.28	0.62	0.60	0.37	10.84
ODAS	27.96	2.42	26.45	1.50	61.30	52.31	0.86	0.36	0.25	7.54
ZOREN	18.51	2.34	16.01	0.01	22.84	52.13	0.68	0.64	0.45	5.57

Table 26: Entropy criteria weights ımportance level for 2021

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
w_j	0.0655	0.1012	0.1016	0.1290	0.1716	0.2000	0.0219	0.0383	0.0767	0.0942

Table 27: Corrected decision matrix for 2022

Criterion aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	NP	GP	CRTD NPG	GPG	EBG	CR	LR	PTC	ATR
AKENR	11.18	0.06	9.00	0.04	155.28	186.97	1.11	1.09	0.89	14.28
AKSEN	14.03	9.99	11.94	0.13	162.07	164.46	1.43	1.38	1.94	5.61
AKSUE	69.66	7.38	69.22	0.01	96.65	115.56	0.20	0.19	0.43	5.08
AYEN	39.55	23.46	37.86	0.62	353.23	249.27	1.46	1.45	0.95	15.43
ODAS	43.55	30.77	41.97	2.55	738.57	693.29	1.43	0.81	0.96	19.71
ZOREN	15.34	0.37	12.96	0.01	109.12	96.76	0.60	0.56	0.67	5.77

Table 28: Entropy criteria weights ımportance level for 2022

Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
w_j	0.0666	0.1680	0.0792	0.3398	0.0948	0.0845	0.0432	0.0450	0.0343	0.0446

Table 29: Decision matrix for 2013

Criterion Aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	P_{AI}
Companies/Criteria	EBM	CRTD NP	GP	CRTD NPG	CRTD GPG	CRTD EBG	CR	LR	PTC	ATR	(1/m)
AKENR	21.50	2.21	19.38	0.86	0.53	1.01	1.04	0.96	0.27	10.01	0.167
AKSEN	17.46	2.46	12.32	2.15	0.37	1.9	0.83	0.36	0.79	7.87	0.167
AKSUE	46.82	0.01	46.24	2.49	0.01	0.01	7.54	7.37	0.06	12.59	0.167
AYEN	20.71	2.30	16.15	0.01	0.56	2.4	0.62	0.45	0.45	8.24	0.167
ODAS	7.88	2.63	8.37	2.30	1.20	2.31	1.14	0.88	3.04	16.80	0.167
ZOREN	18.06	1.30	2.32	2.21	2.79	0.47	0.32	0.29	0.13	7.30	0.167
w_j	0.0356	0.0542	0.0787	0.0610	0.1243	0.0808	0.1673	0.2064	0.1790	0.0127	

Table 30: Theoretical rating matrix for 2013

Criterion Aspects	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Companies/Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
AKENR	0.0059	0.0091	0.0131	0.0102	0.0208	0.0135	0.0279	0.0345	0.0299	0.0021
AKSEN	0.0059	0.0091	0.0131	0.0102	0.0208	0.0135	0.0279	0.0345	0.0299	0.0021
AKSUE	0.0059	0.0091	0.0131	0.0102	0.0208	0.0135	0.0279	0.0345	0.0299	0.0021
AYEN	0.0059	0.0091	0.0131	0.0102	0.0208	0.0135	0.0279	0.0345	0.0299	0.0021
ODAS	0.0059	0.0091	0.0131	0.0102	0.0208	0.0135	0.0279	0.0345	0.0299	0.0021
ZOREN	0.0059	0.0091	0.0131	0.0102	0.0208	0.0135	0.0279	0.0345	0.0299	0.0021

Table 31: Maximum and minimum values for 2013

Companies/Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
Xij+	46.8162	2.6300	46.2448	2.4900	2.7900	2.4000	7.5446	7.3670	3.0423	16.8026
Xij-	7.8789	0.0100	2.3201	0.0100	0.0100	0.0100	0.3211	0.2900	0.0562	7.3034

Table 32: Actual rating matrix for 2013

Companies/Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
AKENR	0.0021	0.0076	0.0051	0.0035	0.0039	0.0056	0.0028	0.0032	0.0022	0.0006
AKSEN	0.0015	0.0085	0.0030	0.0088	0.0027	0.0107	0.0019	0.0003	0.0074	0.0001
AKSUE	0.0059	0.0000	0.0131	0.0102	0.0000	0.0000	0.0279	0.0345	0.0000	0.0012
AYEN	0.0020	0.0079	0.0041	0.0000	0.0041	0.0135	0.0012	0.0008	0.0040	0.0002
ODAS	0.0000	0.0091	0.0018	0.0094	0.0089	0.0130	0.0032	0.0029	0.0299	0.0021
ZOREN	0.0016	0.0045	0.0000	0.0090	0.0208	0.0026	0.0000	0.0000	0.0008	0.0000

Table 33: Gap Matrix for 2013

Companies/Criteria	EBM	NP	GP	NPG	GPG	EBG	CR	LR	PTC	ATR
AKENR	0.0039	0.0015	0.0080	0.0067	0.0169	0.0078	0.0251	0.0312	0.0277	0.0015
AKSEN	0.0045	0.0006	0.0102	0.0014	0.0181	0.0028	0.0260	0.0341	0.0225	0.0020
AKSUE	0.0000	0.0091	0.0000	0.0000	0.0208	0.0135	0.0000	0.0000	0.0299	0.0009
AYEN	0.0040	0.0011	0.0090	0.0102	0.0167	0.0000	0.0268	0.0337	0.0259	0.0019
ODAS	0.0059	0.0000	0.0113	0.0008	0.0119	0.0005	0.0248	0.0316	0.0000	0.0000
ZOREN	0.0044	0.0046	0.0131	0.0012	0.0000	0.0109	0.0279	0.0345	0.0291	0.0021

Table 34: Ranking of alternatives for 2013

Companies	*Qi*	Ranking
AKENR	0.1304	6
AKSEN	0.1221	3
AKSUE	0.0741	1
AYEN	0.1293	5
ODAS	0.0868	2
ZOREN	0.1278	4

Table 35: Ranking of Alternatives for 2014

Companies	Q_i	Ranking
AKENR	0.1353	6
AKSEN	0.1128	5
AKSUE	0.0821	1
AYEN	0.1088	3
ODAS	0.0984	2
ZOREN	0.1122	4

Table 36: Ranking of alternatives for 2015

Companies	Q_i	Ranking
AKENR	0.1031	3
AKSEN	0.1050	4
AKSUE	0.0424	1
AYEN	0.1116	6
ODAS	0.0920	2
ZOREN	0.1108	5

Table 37: Ranking of alternatives for 2016

Companies	Q_i	Ranking
AKENR	0.1324	6
AKSEN	0.0980	5
AKSUE	0.1143	4
AYEN	0.0798	2
ODAS	0.0540	1
ZOREN	0.0827	3

Table 38: Ranking of alternatives for 2017

Companies	Q_i	Ranking
AKENR	0.1168	4
AKSEN	0.0820	2
AKSUE	0.1308	6
AYEN	0.1011	3
ODAS	0.1233	5
ZOREN	0.0455	1

Table 39: Ranking of alternatives for 2018

Companies	Q_i	Ranking
AKENR	0.1198	5
AKSEN	0.0723	1
AKSUE	0.0753	2
AYEN	0.0936	4
ODAS	0.1299	6
ZOREN	0.0807	3

The decision matrix for 2016 was calculated through formula 1 and presented in Table 15.

When Table 16 is analyzed, the most important criterion in 2016 was NPG criterion with a value of 0.1909, while the least important criterion was determined as ATR criterion with a value of 0.0086.

Table 40: Ranking of alternatives for 2019

Companies	Q_i	Ranking
AKENR	0.0915	4
AKSEN	0.0836	3
AKSUE	0.0749	2
AYEN	0.1033	5
ODAS	0.0720	1
ZOREN	0.1210	6

Table 41: Ranking of alternatives for 2020

Companies	Q_i	Ranking
AKENR	0.0919	3
AKSEN	0.0601	1
AKSUE	0.1098	5
AYEN	0.1227	6
ODAS	0.0820	2
ZOREN	0.0930	4

Table 42: Ranking of alternatives for 2021

Companies	Q_i	Ranking
AKENR	0.0454	1
AKSEN	0.0897	3
AKSUE	0.1171	4
AYEN	0.0746	2
ODAS	0.1179	5
ZOREN	0.1396	6

Table 43: Ranking of alternatives for 2022

Companies	Q_i	Ranking
AKENR	0.1457	5
AKSEN	0.1307	3
AKSUE	0.1355	4
AYEN	0.0884	2
ODAS	0.0187	1
ZOREN	0.1590	6

The decision matrix for 2017 was calculated through formula 1 and presented in Table 17.

When Table 18 is analyzed, it is seen that the criterion with the highest degree of importance among the criteria used in the analysis of the companies in the Electricity, Gas and Water Sector for 2017 is determined as GPG criterion with a value of 0.3657, while the criterion with the lowest degree of importance is determined as LR criterion with a value of 0.0238.

The decision matrix for 2018 was calculated through formula 1 and presented in Table 19.

2018 criterion importance weights are given in Table 20. When Table 20 is examined, the criterion with the highest degree of importance in 2018 was determined as GPG criterion with a value of 0.1907, while the criterion with the lowest degree of importance was determined as CR criterion with a value of 0.0349.

The decision matrix for 2019 was calculated through formula 1 and presented in Table 21.

When Table 22 is analyzed, the criterion with the highest degree of importance in 2019 was determined as the GPG criterion with a value of 0.2623, while the criterion with the lowest degree of importance was determined as the CR criterion with a value of 0.0211.

The decision matrix for 2020 was calculated through formula 1 and presented in Table 23.

When Table 24 is analyzed, the criterion with the highest degree of importance in 2020 was determined as NP criterion with a value of 0.1640, while the criterion with the lowest degree of importance was obtained as EBG criterion with a value of 0.0469.

The decision matrix for 2021 was calculated through formula 1 and presented in Table 25.

When Table 26 is analyzed, the criterion with the highest degree of importance in 2021 is determined as EBG criterion with a value of 0.2000, while the criterion with the lowest degree of importance is determined as CR criterion with a value of 0.0219.

The decision matrix for 2022 was calculated through formula 1 and presented in Table 27.

When Table 28 is analyzed, the criterion with the highest degree of importance in 2022 is determined as NPG criterion with a value of 0.3398, while the criterion with the lowest degree of importance is obtained as PTC criterion with a value of 0.0343.

4.2. MAIRCA Analysis Results

The decision matrix and (w_j) (criteria weight importance levels) obtained separately for each year through the Entropy method were used in the MAIRCA method and the necessary calculation steps were followed and the financial performance score values of the companies for the years 2013-2022 were calculated. Table 29 shows the decision matrix for 2013 obtained by the Entropy method, the (w_j) value and the value calculated by formula 9.

The theoretical rating matrix was obtained using Formula 12 and shown in Table 30.

Since all the evaluation criteria used in the study are maximization (benefit) oriented, the values in the empirical rating matrix were calculated using Formula 13 and presented in Table 31.

The empirical rating matrix was obtained through Formula 15 and provided in Table 32.

The gap matrix was created using Formula 16 and shown in Table 33.

The values of the criterion functions were calculated for each alternative using Formula 18, resulting in score values. The score values are presented in Table 34.

According to the results of the MAIRCA analysis, as examined in Table 34, the most successful company in terms of financial performance in the Electricity, Gas and Water Sector in 2013 was AKSUE (0.0741), while the least successful company was AKENR (0.1304).

As seen in Table 35, in 2014, the most successful company in terms of financial performance was AKSUE (0.0821), and the least successful company was AKENR (0.1353).

Table 36 shows that in 2015, the most successful company in terms of financial performance was AKSUE (0.0424), while the least successful company was AYEN (0.1116).

According to Table 37, in 2016, the most successful company in terms of financial performance was ODAS (0.0540), and the least successful company was AKENR (0.1324).

As noted in Table 38, in 2017, the most successful company in terms of financial performance was ZOREN (0.0455), while the least successful company was AKSUE (0.1308).

In 2018, as shown in Table 39, the most successful company in terms of financial performance was AKSEN (0.0723), while the least successful company was ODAS (0.1299).

According to Table 40, in 2019, the most successful company in the Electricity, Gas, and Water Sector in terms of financial performance was ODAS (0.0720), while the least successful company was ZOREN (0.1210).

As examined in Table 41, in 2020, the most successful company in terms of financial performance was AKSEN (0.0601), while the least successful company was AYEN (0.1227).

According to Table 42, in 2021, the most successful company in terms of financial performance was AKENR (0.0454), while the least successful company was ZOREN (0.1396).

Finally, as shown in Table 43, in 2022, the most successful company in terms of financial performance was ODAS (0.0187), while the least successful company was ZOREN (0.1590).

5. CONCLUSION

In the initial phase of the research, the Entropy Analysis method was employed to weight the financial ratios used as evaluation criteria. Each year, the criteria with the highest and lowest levels of importance were identified. According to the 2013 analysis, the criterion with the highest importance was the LR. In 2014, 2017, 2018, and 2019, the highest importance was attributed to the GPG, while in 2015, it was the CR.

In 2016 and 2022, the highest importance was found to be the NPG, and in 2020, the NP held the highest importance. Finally, in 2021, the EBG was identified as the most important criterion. Since these ratios are maximization-oriented, higher values in the most important criteria for each year have a positive effect on a company's financial performance. Companies striving to improve their financial performance can enhance their success by increasing these ratios.

According to the MAIRCA analysis, AKSUE was the most financially successful company for three consecutive years (2013-2015), while AKENR was the least successful in 2013 and 2014, and AYEN took this position in 2015. The reasons for the success or failure of these companies were examined using financial statements, activity reports, and material disclosures obtained from the PDP. In 2013, the AKSUE company had the highest CR, LR, NPG, EBG, and GPG. In 2014, the company maintained a high CR and LR, and the completion of its solar power plant installation contributed to its financial success. In 2015, the company's profit increased compared to previous years, making it the leader in NPG, NP, GP, CR and LR within its sector. Additionally, the energy sales from the solar power plant, which began operations in 2014, further supported AKSUE's financial success.

AKENR, on the other hand, experienced increased cost of sales in both 2013 and 2014 and incurred losses in both years. Furthermore, in 2014, the company decided to cease production activities at the "Bozüyük Natural Gas Combined Cycle Power Plant" due to prevailing market conditions, as stated in its material disclosures. These factors contributed to AKENR being the least successful company in 2013 and 2014. In 2015, AYEN was identified as the least successful company due to increased cost of sales, a decrease in gross profit, and significant losses compared to the previous year. Additionally, its CR and LR fell below 1, negatively impacting its success.

In 2016, ODAS was the most successful company, while AKENR remained the least successful. ODAS reported that it was not negatively impacted by price fluctuations in the sector and saw growth in total installed capacity and renewable energy production. These factors contributed to the company's success. AKENR experienced a decrease in hydrological flows and a lower average market clearing price, leading to significant declines in sales revenue and gross profit, which negatively affected its financial performance.

In 2017, ZOREN emerged as the most successful company, while AKSUE was the least successful. ZOREN saw increases in sales revenue and gross profit and shifted from a loss in the previous year to a significant net profit in 2017. AKSUE, however, experienced a notable increase in cost of sales, coupled with declines in gross profit and operating profit, leading to higher losses and a poor performance.

In 2018, AKSEN was the most successful company, while ODAS was the least successful. ODAS incurred significant losses and witnessed declines in gross and operating profits, which negatively affected its performance. In contrast, AKSEN achieved growth in sales revenue, gross profit, and operating profit. Additionally, the company expanded its operations by signing new business agreements and increasing the installed capacity of its power plant in Ghana, which contributed positively to its performance.

In 2019, ODAS was the most successful company, while ZOREN was the least successful. ODAS saw increases in sales revenue, gross profit, and operating profit compared to previous years. ZOREN, on the other hand, faced challenges with its wind power plants and natural gas plant production, resulting in significant losses and a decline in its financial performance.

In 2020, AKSEN was the most successful company, while AYEN was the least successful. AKSEN's financial statements showed notable increases in sales revenue, gross profit, operating profit, and net profit. Furthermore, the company made an investment in Uzbekistan, marking its first venture into Asia, and applied for energy export permits to Iraq. Despite the global challenges posed by COVID-19, AKSEN's revenue grew significantly, boosting its profitability and financial success.

In 2021 and 2022, ZOREN was the least successful company. In 2021, AKENR was the most successful, while in 2022, ODAS achieved this position. ZOREN's financial statements for 2021 indicated a significant increase in cost of sales, while in 2022, the company announced the liquidation of its Kazakh branch, negatively impacting its performance. AKENR's 2021 financial statements revealed increases in sales revenue, gross profit, and operating profit and the company also reported that it had expanded its installed capacity and joined the European Energy Exchange. These developments contributed to AKENR being the most successful company in its sector in 2021. ODAS, in 2022, saw growth in sales revenue, gross profit, and operating profit, and after incurring losses in 2020 and 2021, the company achieved significant profitability in 2022. ODAS also expanded its power plant in Uzbekistan and maintained an upward trend in its renewable energy portfolio, positively influencing its financial performance.

This study contributes to the literature by analyzing a decade (2013-2022) of data and utilizing a comprehensive set of financial ratios not previously applied or only partially used in other energy sector studies. The use of the Entropy Analysis method for weighting criteria and the MAIRCA method for performance ranking further enhances the originality of the research. Future studies could benefit from incorporating additional evaluation criteria and exploring different weighting and performance ranking methods.

REFERENCES

Akgün, A. (2022), Financial evaluation of BIST energy companies with CRITIC and CODAS ıntegrated approach. Journal of Selcuk University Social Sciences Institute Journal, 20(48), 338-356.

Arsu, T. (2021), Assessment of financial performance by entropy based ARAS method: An application on businesses in BIST electricity, gas and steam sector. Hacettepe University Faculty of Economics and Administrative Sciences Journal, 39(1), 15-32.

Ayçin, E. (2020), Multi-Criteria Decision Making: Computer Implemented Solutions. 2nd ed. Ankara: Nobel Academic Publishing.

Babacan, A., Tuncay, M. (2022), Interaction between working capital and financial performance in the turkish energy sector: A comparative research by the SWARA, AHP and TOPSIS. Mehmet Akif Ersoy University Faculty of Economics and Administrative Sciences Journal, 9(3), 1976-2005.

Bektaş, S. (2023), Evaluation of financial performance of energy companies traded in Bist 100 With MEREC and MABAC methods. Dokuz Eylul University Faculty of Business Administration Journal,

24(2), 115-128.
Chatterjee, K., Pamucar, D., Zavadskas, E.K. (2018), Evaluating the performance of suppliers based on using the R'AMATEL-MAIRCA method for green supply chain implementation in electronics industry. Journal of Cleaner Production, 184, 101-129.
Çiftçi, H.N., Ve Yıldırım, B.F. (2020), Financial performance evaluation of companies quoted in bist energy sector: Example of time period based on grey numbers. Accounting Science World Journal, 22(3), 384-404.
Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Seyboth, K., Matschoss, P., Kadner, S., Stechow, C. (2011), Renewable Energy Sources and Climate Change Mitigation. 1st ed. Cambridge: Cambridge University Press. p1-105.
Erol, I., Ferrell, W.G. Jr. (2009), Integrated approach for reorganizing purchasing: Theory and a case analysis on a Turkish company. Computers and Industrial Engineering, 56(4), 1192-1204.
Ersoy, N., Taslak, S. (2023), Comparative analysis of MCDM Methods for the assessment of corporate sustainability performance in energy sector. Ege Academic Review, 23(3), 341-362.
Eyüboglu, K., Ve Çelik, P. (2016), Financial performance evaluation of turkish energy companies with fuzzy AHP and Fuzzy topsis methods. Business and Economics Research Journal, 7(3), 21-37.
Gigovic, L., Pamučar, D., Bajić, Z., Milićević, M. (2016), The combination of expert judgment and GIS-MAIRCA analysis for the selection of sites for ammunition depots. Sustainability, 8(4), 372.
Karakul, A.K., Özaydın, G. (2019), Financial performance evaluation by using TOPSIS and VIKOR methods: An application on XELKT. Dumlupinar University Journal of Social Sciences, 21(60), 68-86.
Karcıoğlu, R., Yalçın, S., Gültekin, Ö.F. (2020), Financial performance analysis using intuitionistic fuzzy logic and entropy based multi-criteria decision making method: An application on energy companies traded in BIST. MANAS Journal of Social Research, 9(1), 360-372.
Katsamppoxakis, I., Christopoulos, A., Kalantonis, P., Nastas, V. (2022), Crude oil price shocks and European stock markets during the COVID-19 period. Energies, 15, 4090.
Lam, W.S., Lam, W.H., Jaaman, S.H. (2021), Portfolio optimization with a mean–absolute deviation–entropy multi-objective model. Entropy, 23(10), 1266.
Makki, A.A., Alqahtani, A.Y. (2023), Capturing the effect of the COVID-19 pandemic outbreak on the financial performance disparities in the energy sector: A Hybrid MCDM-based evaluation approach. Economies, 11(2), 61.
Medetoğlu, B., Kavas, Y.B., Öztürk, M. (2023), Financial performance analysis: An application on the BIST electric gas and steam industry with TOPSIS and MOORA methods. EKEV Academy Journal, 11(94), 330-344.
Mercan, Y., Çetin, O. (2020), Financial performance analysis of BIST electricity index companies with COPRAS and VIKOR methods. International Journal of Afro-Eurasian Research, 5(9), 123-139.
Metin, S., Yaman, S., Korkmaz, T. (2017), Determination of the financial performance by TOPSIS and MOORA methods: A comparative application on BIST energy companies. Kahramanmaraş Sütçü İmam University Social Sciences Journal, 14(2), 371-394.
Ntanos, S., Skordoulis, M., Kyriakopoulos, G., Arabatzis, G., Chalikias, M., Galatsidas, S., Batzios, A., Katsarou, A. (2018), Renewable energy and economic growth: Evidence from European countries. Sustainability, 10, 2626.
Orçun, Ç. (2019), Performance analysis with WASPAS method in energy sector. Bolu Abant Izzet Baysal University Social Sciences Institute Journal, 19(2), 439-453.
Özdemir, O., Parmaksiz, S. (2022), Comparison of financial performance of BIST energy enterprises with multi-criteria decisionmaking techniques: Analysis with TOPSIS and EDAS methods. Başkent University Faculty of Commercial Sciences Journal, 6(1), 34-56.
Pamucar, D., Lukovac, V., Božanić, D., Komazec, N. (2018), Multi-criteria FUCOM-MAIRCA model for the evaluation of level crossings: Case study in the Republic of Serbia. Operational Research in Engineering Sciences: Theory and Applications, 1(1), 108-129.
Purba, J.H.V., Bimantara, D. (2020), The influence of asset management on financial performance. Atlantis Press, 143, 150-155.
Randolph, J., Masters, G.M. (2008), Energy for Sustainability: Technology, Planning, Policy. 2nd ed. USA: Island Press. p1-637.
Sakarya, Ş., Yıldırım, H.H., Akkuş, H.T. (2015), Determination of Financial Performance of Energy Companies Traded in BIST by Using TOPSIS Multi-Criteria Decision Making Method. Hitit University, 19th Finance Symposium Çorum. p601-616.
Sonmez, F., Baysal, G., Baysal, I.A., Bademcioglu, M. (2023), Determining the financial performances of BIST100 energy companies by TOPSIS Method. PressAcademia Procedia, 16, 149-155.
Tan, Y.S., Ng, Y.T., Low, J.S.C. (2017), Internet-of-things enabled real-time monitoring of energy efficiency on manufacturing shop floors. Procedia CIRP, 61, 376-381.
Terzioğlu, M.K., Kurt, E.S., Yaşar, A., Köken, M. (2022), BIST100-energy sector financial performance: SWARA-VIKOR and SWARA-WASPAS. Alanya Academic Review Journal, 6(2), 2439-2455.
Topal, A. (2021), Financial performance analysis of electricity generation companies with multi-criteria decision making: Entropy-based cocoso method. Business and Management Studies: An International Journal, 9(2), 532-546.
Yalçın, İ., Ersoy, H. (2024), Performance measurement of companies based on cash flow analysis: A research on energy companies traded in Borsa Istanbul. Research of Financial Economic and Social Studies, 9(1), 63-82.
Yaşar, A., Terzioğlu, M.,K. (2022), Financial performance analysis of enterprises in the energy sector with the entropy based aras and GRI Method. BILTURK. The Journal of Economics and Related Studies, 4(3), 145-159.
Yufang, S., Wanli, H. (2021), Governance evaluation of listed mining companies based on Entropy method. In: E3S Web of Conferences. EDP Sciences. Vol. 251, p. 01117.
Zhang, H., Gu, C., Gu, L., Zhang, Y. (2011), The evaluation of tourism destination competitiveness by TOPSIS and information entropy-a case in the Yangtze River Delta of China. Tourism Management, 32, 443-451.