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Determination of Financial Performance in Electric Power Enterprises with Entropy Weighted WASPAS Analysis Method

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ABSTRACT

In this study, Entropy weighted WASPAS method is applied to measure the financial performance of 11 electric power enterprises operating in Borsa Istanbul (BIST) for the period of 2022. 7 financial ratios for the year 2022 were accepted as criteria and the financial success ranking of 11 electric power enterprises was made. The financial ratios used in the study were selected among the ratios that can provide information about the liquidity and profitability status of the enterprises. In the first stage of the application, Entropy method was used to determine the criteria weights. The determined criteria weights were prioritized and used in the WASPAS (Weighted Aggregated Sum Product Assessment) method. Then, the financial performance of electric energy enterprises was ranked by making an evaluation with the WASPAS method.

Entropi Ağırlıklı WASPAS Analiz Yöntemi İle Elektrik Enerji İşletmelerinde Finansal Performansın Belirlenmesi

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Sorumlu Yazar
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Anahtar Kelimeler
Finansal performans değerlendirmesi
Finansal oranlar
Entropi yöntemi
WASPAS yöntem

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ÖZ

Bu çalışmada Borsa İstanbul'da (BIST) faaliyet gösteren 11 elektrik enerji işletmesinin 2022 dönemine ait finansal performanslarını ölçmek için Entropi ağırlıklı WASPAS yöntemi uygulanmıştır. 2022 yılına ait 7 finansal oran kriter kabul edilerek 11 elektrik enerji işletmesinin finansal başarı sıralaması yapılmıştır. Çalışmada kullanılan finansal oranlar işletmelerin likidite durumu ve karlılık durumu hakkında bilgi verebilecek nitelikteki oranlar arasından seçilmiştir. Uygulamanın ilk aşamasında kriter ağırlıklarının belirlenmesi için Entropi yöntemi kullanılmıştır. Belirlenen kriter ağırlıkları önceliklendirilerek WASPAS yöntemi içerisinde kullanılmıştır. Daha sonra WASPAS yöntemiyle bir değerlendirme yapılarak elektrik enerji işletmelerinin finansal performansı sıralanmıştır.

1. INTRODUCTION

With the advancement of technology and the increase in population, the dependence of society and businesses on energy to sustain their daily activities is constantly increasing. Increasing energy demand has also increased the importance of businesses operating in this sector. At this point, it is important to meet these needs by utilizing different energy sources. Electric energy is the most widespread and important among these sources today [1].

Electricity consumption in Turkey increased rapidly until the end of 2018. In 2019 and 2020, electricity consumption is almost unchanged. After a high increase in 2021 due to the post-Covid-19 recovery effect, the distribution of economic activity started to change in 2022 as the share of the service sector in the economy increased, which had an impact on electricity consumption. Studies have estimated that the industrial and service sectors will account for more than 50% of Turkey's annual electricity consumption in 2035 [2].

The sector-based data of the electricity demanded in Turkey in 2019, 2021 and 2022 are shown in Figure 1.

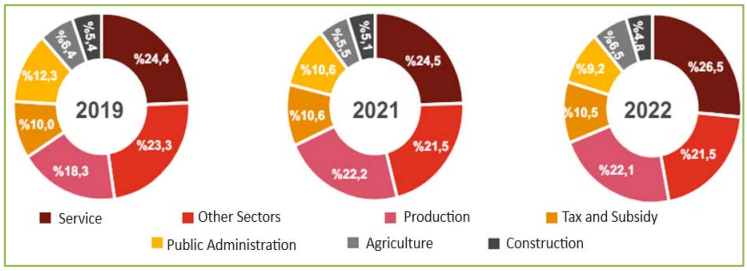

Figure 1. Electricity demand by sector [2]

The fact that electric power enterprises are important and strategic for the Turkish economy has been an encouraging factor in the realization of the study. As a result of the decrease in the share of the public sector and the increase in the share of the private sector in electricity energy enterprises over the years, the importance of the efficiency and financial strength of energy companies increases even more. For this reason, businesses in the energy sector have to carry out their activities effectively and efficiently [3]. The financial performance of a company is an indicator of how efficiently that company performs its activities [4]. If the financial performance of electric energy companies is low, it is not possible for them to successfully carry out their production and distribution activities, which may cause problems in meeting the demand.

Financial performance has a critical role in the strategic decisions of businesses. Financial performance is used in the process of evaluating the financial activity results of enterprises [5]. As in all sectors, it is important to analyze financial data to determine the role and financial status of the electricity energy sector in the national economy [6]. These analyses play a critical role in shaping the future decisions of businesses. Because a solid financial foundation helps businesses to determine their future strategic plans and achieve their goals.

Decision making is an important part of life. Entropy and WASPAS method, which is one of the multi-criteria decision-making methods used in the decision-making process, is a technique that allows the most appropriate one to be selected among the alternatives [7]. Although the Entropy and WASPAS method is used in the literature to determine the financial performance ranking of enterprises operating in different sectors such as automotive, transportation, food, technology, etc., it has shown that this method can also be applied to an important sector such as electric energy enterprises.

The study aims to evaluate the financial performance of 11 electric power enterprises operating in Borsa Istanbul (BIST), which are included in the "BIST 100" and "BIST ELECTRIC" indices. These enterprises operate at various points of the Turkish electricity market value chain. While evaluating the performance of the enterprises, financial ratios that can provide information about the liquidity and profitability status of the enterprises were utilized.

1.1. Financial Ratios (Performance Indicators)

Financial ratios used in performance analysis are grouped as liquidity ratios, financial ratios, operating ratios and profitability ratios according to the way they are used [8]. In this study, among the financial ratios, ratios showing the liquidity, financial structure and profitability of companies were used. The ratios determined as decision criteria were determined by analyzing similar studies in the literature.

The explanations and formulas of the financial performance indicators used in the research are given below.

Liquidity Ratio (Acid-Test Ratio): It is the ratio obtained by subtracting the inventories from the current assets of the enterprises and then dividing them by short-term liabilities. It measures the capacity of enterprises to meet their short-term debts. The Acid-Test Ratio is a ratio that complements the current ratio. A ratio of 1 is generally considered sufficient. In case the liquidity ratio is less than 1, it depends on the stocks of the enterprise in the payment of short-term debts. (Current Assets-Stocks)/Short-Term Liabilities is calculated [9].

Cash Ratio: It shows the ability of the company to meet its short-term debts in the event that its sales stop and it cannot collect its receivables. It is calculated by dividing (Cash and Cash Equivalents / Short Term Liabilities) [9].

Current Ratio: It is a ratio that shows the extent to which the company can meet its short-term debts and is the most widely used ratio in financial performance analysis in order to determine the capital adequacy of the business. It is calculated by dividing (Current Assets / Short-Term Debts) [9].

Operating Profitability: It shows the operating profitability of the business over sales. If the ratio is high, it indicates that the main activity of the business is profitable and efficient, while the downward trend of the ratio indicates that profitability and efficiency are decreasing. (Operating Profit / Net Sales) is calculated [9].

Net Profitability: It reflects the overall efficiency and profitability of the business's activities. It is the profit obtained as a result of subtracting the total expenses spent for the realization of these activities from the total income obtained from all activities of the enterprise in a certain period. (Net Profit / Net Sales) is calculated [9].

Return on Equity: It is a financial performance measure that shows how much profit a business makes with its equity. It is calculated as (Net Profit / Equity) [9].

Financial Leverage: It shows what percentage of the assets owned by the business is financed by debts. A higher leverage ratio indicates that the company has higher financial risk. (Total Debt / Total Assets) is calculated [9].

The study consists of six chapters. In the second section, previous studies are included. Entropy and WASPAS methods are discussed in the third chapter. In the fourth section, the decision criteria to be used in the study are explained. In the fifth section, Entropy and WASPAS models are used to evaluate the financial performance of 11 electric power enterprises considering 7 different criteria. In the conclusion section, the findings are explained in detail and suggestions for future studies are presented.

1.2. Literature Review

Within the scope of the research, a selection was made from the studies conducted in the past years in order to reach the most up-to-date information. These studies, which include applications, are detailed below.

There are different studies in the literature that measure the performance of electricity and energy sectors. In these studies, different techniques from multi-criteria decision making methods were used in performance measurements. Some studies used TOPSIS method, while others used Entropy, VIKOR, EDAS, COCOSO and WASPAS methods. In general, TOPSIS method is more predominant. The majority of the studies in which financial performance criteria were weighted by the Entropy method and decision alternatives were ranked by the WASPAS method were conducted in the banking sector.

There are examples of studies on financial performance measurement in the energy sector. Akgün [3], in his study, evaluated the enterprises operating in the energy sector registered in Borsa Istanbul with CRITIC and CODAS approach, one of the multi-criteria decision making methods. In the study, 13 financial ratios were used as decision criteria. These financial ratios are the data for the 2020 and 2021 periods on the Public Disclosure Platform (KAP). CRITIC method was used for weighting the criteria. CODAS method was used for prioritization among alternatives. Metin et al. examined the relationship between stock market returns and financial performance of three energy companies listed in Borsa Istanbul. It is concluded that the company with the highest performance is Ayen Energy. Sakarya et al. [10] used the TOPSIS method, one of the multi-criteria decision-making methods, to measure the financial performance of 14 energy companies traded in Borsa Istanbul. Studies on Entropy and WASPAS methods available in the literature are also summarized. Baykal et al. [11] evaluated the financial performance rankings of life and pension insurance companies operating in Turkey using Entropy-based WASPAS method. Kangal [12] evaluated the financial performance of energy enterprises operating in Turkey in the electricity, steam and gas sector registered in Borsa Istanbul in 2020. In the study, the weights of the criteria needed were determined by the Entropy method. Then, financial performance measurement was made with the WASPAS method, one of the multi-criteria decision-making methods. Çilek et al. [13] determined the priorities of the criteria using the Entropy method to determine the banking performance of the cities in the Black Sea Region. After determining the priorities of the criteria, the banking performance rankings of the cities in the Black Sea Region in Turkey were made with the WASPAS technique. As a result of the analysis, the best performing city for 2014-2019 was Samsun, while the worst performing cities were Kastamonu and Tokat. Eş et al. [14] evaluated the asset size performance of banks by applying Entropy and WASPAS methods in their study. A data set covering the years 2015-2019 was utilized. In the analysis, the importance levels of the criteria were calculated with the Entropy method. The WASPAS method was applied with the calculated importance levels and the performance ranking was made. As a result of the analysis, it was determined that Garanti Bank had the best performance in 2015, Ziraat Bank in 2016-2017 and Yapı ve Kredi Bank in 2018-2019. Orçun [15] applied the WASPAS method in the energy sector to evaluate the financial performance of companies. Karaca et al. [16] used Entropy and WASPAS methods to select the appropriate renewable energy source for Turkey. With the Entropy method, the criteria of renewable energy sources were ranked according to their importance. In the second stage, the WASPAS method was used to suggest which renewable energy source would be the most suitable renewable energy source in Turkey. Ural et al. [17], the performances of 3 state-owned banks operating in Turkey were analyzed using Entropy and WASPAS methods by utilizing financial statements for the period 2012-2016. According to the results obtained from the study, it was determined that the best performing bank in 2012 and 2013 was Türkiye Vakıflar Bankası, and the best performing public capital bank in 2014, 2015 and 2016 was Türkiye Cumhuriyeti Ziraat Bankası A.Ş. Akçakanat et al. [18] grouped the banks operating in Turkey as small, medium and large scale according to their asset sizes. They evaluated the performance analysis of banks with the Entropy-based WASPAS method. In the study, the first 9 months of 2016 data from the Forbes Magazine Banks Report were utilized. The 6 criteria determined for the performance analysis measurement of the banks were weighted by the Entropy method. Then, the banks were grouped according to their scales using the WASPAS method and ranked according to their performance. As a result, it was observed that Ziraat Bank was the best performing bank among large-scale banks, Finansbank among medium-scale banks and Anadolubank among small-scale banks.

Orçun [15], Topal [4] and Ömürbek [8] can be cited in the literature review conducted during our research. Most of the studies on the WASPAS method have focused on the banking sector. In Turkey, there are no studies in which Entropy and WASPAS methods are applied together to the financial performance of electric energy enterprises operating in Borsa Istanbul, included in the BIST 100 and also included in the BIST Electricity index. Therefore, it is thought to contribute to the literature.

2. MATERIAL AND METHODS

The problems that the decision maker may face when starting a solution are usually the determination of which method is the appropriate method. When determining the appropriate method, the structure of the problem and the characteristics of the process should be considered [19]. In order to reach the best result in multi-criteria decision-making problems, different multi-criteria decision-making techniques can be used [20]. Multi-criteria decision making (MCDM) is a method that allows the selection of the best alternative among multiple criteria. The application process of all MCDM techniques consists of three stages. In the first stage, criteria and alternatives are identified. In the second stage, weights indicating the importance of

the criteria are determined and alternatives are evaluated according to these criteria. In the third stage, each alternative is ranked according to the method whose numerical values are determined [21]. In this study, the Entropy method, which is an objective evaluation method, was used for weighting the decision criteria, and the WASPAS method was used for ranking the alternatives.

2.1. Entropy Method

The concept of entropy was defined in the literature by Rudolph Clausius (1865) as a measure of uncertainty in the system. It was later developed by Shannon's work and adapted to information theory [22]. Entropy method is used to calculate the weights of the criteria in the decision problem [1].

Entropy method consists of 5 steps [25].

Step 1: Decision matrix is created.

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & a_{1n} \\ a_{21} & a_{22} & a_{2n} \\ \dots & \dots & \dots \\ a_{m1} & a_{m2} & a_{mn} \end{bmatrix} \quad (1)$$

i=1,2.....,m (alternatives) and j=1,2.....,n (criteria)

Step 2: The decision matrix is normalized.

Criteria are normalized without distinguishing between benefit and cost functions. The values in the decision matrix are normalized by dividing by the column sums.

The value of p_{ij} is calculated by normalization.

$$p_{ij} = \frac{a_{ij}}{\sum_{i=1}^{m} a_{ij}} \quad (2)$$

p_{ij} : Normalized values
a_{ij} : Given benefit values

Step 3: Entropy values are calculated.

The entropy value for the criteria is found with the help of the equations given below.

$$E_j = -k. \sum_{i=1}^{m} p_{ij} . \ln(p_{ij}) \quad (3)$$

$$k = (ln(m))^{-1} \quad (4)$$

k: Entropy value coefficient
E_j: Entropy value
p_{ij} : Refers to normalized values

Step 4: Deviation values for each criterion are found with the help of the equation given below.

$$d_j = 1 - E_j \quad (5)$$

Step 5: To determine the importance level of criterion j, weight values w_j are calculated for each criterion.

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \quad (6)$$

2.2. WASPAS Method

WASPAS method is a multi-criteria decision-making method based on weighted sum model and weighted product model methods. This method, developed by Zavadskas et al. in 2012, reveals the performance values of the selected alternatives using criterion weights. As a result of the solution, the alternatives are evaluated and ranked from best to worst. The main purpose of the method is to maximize the ranking accuracy [23]. There is no technique for determining the criteria weights in the WASPAS method. Therefore, Entropy method was used to determine the criteria weights in this study.

The WASPAS method consists of 6 steps [23].

Step 1: Decision matrix is created.

$$X = \begin{bmatrix} x_{11} & x_{12} & x_{1n} \\ x_{21} & x_{22} & x_{2n} \\ \dots & \dots & \dots \\ x_{m1} & x_{m2} & x_{mn} \end{bmatrix} \quad (7)$$

Step 2: The decision matrix is normalized. Normalization is carried out using the formula in equation (8) for benefit-side criteria and equation (9) for cost-side criteria.

$$\bar{xij} = x_{ij} / max_i (x_{ij}) \quad i = 1,2, \dots , m \; ; j = 1,2,\dots,n \quad (8)$$

$$\bar{xij} = min_i (x_{ij}) / x_{ij} \quad i = 1,2, \dots , m \; ; j = 1,2,\dots,n \quad (9)$$

Step 3: Calculate the total relative importance of alternative i. in terms of the Weighted Sum Model (WSM). The total relative importance is calculated by multiplying the i^{th} alternative value by the weight value of each criterion and then summing each alternative value respectively as in equation (10) [24].

$$Q_i^{(1)} = \sum_{j=1}^{n} \bar{x}_{ij} \cdot w_j \quad (10)$$

Step 4: Calculate the total relative importance of alternative i in terms of the Weighted Multiplicative Model (WPM). The power of the relevant criterion weight is taken for the value of each i. alternative criterion over the normalized decision matrix and the values found are multiplied for each alternative respectively and the $Q_i^{(2)}$ value is calculated as in equation (11) [24].

$$Q_i^{(2)} = \prod_{j=1}^{n} (\bar{x}_{ij})^{w_j} \quad (11)$$

Step 5: Calculate the weighted common overall criterion value for the Weighted Sum (WSM) and Weighted Product Models (WPM). The relative importance of decision alternatives is calculated as in equation (12).

$$Q_i = \lambda . Q_i^{(1)} + (1 - \lambda) . Q_i^{(2)} \quad (12)$$

Step 6: After the alternatives are identified, they are ranked according to the Q value. The highest value of Q is selected as the best alternative.

3. DATA SET OF THE STUDY

Within the scope of the study, 11 electric energy enterprises operating in Borsa Istanbul (BIST) are included. The data set of the study consists of financial data obtained from the financial statements and annual reports of all 11 companies for the year 2022. In this section, 7 financial ratios are accepted as criteria and the success ranking of 11 electric power companies is tried to be made. The criteria used in the study were weighted with the Entropy method, and then the performance ranking was carried out with the WASPAS method. The data of the study were analyzed with MS. Office Excel Program.

The financial ratios used in the study were selected among the ratios that can provide information about the liquidity and profitability status of the enterprises. It is included in Table 1 [8].

Table 1. Decision criteria used in the study [8]

Financial performance indicators	Codes	Direction
Operating profitability	**FAKA**	Maximum (Benefit)
Net profitability	**NK**	Maximum (Benefit)
Current ratio	**CO**	Maximum (Benefit)
Liquidity ratio	**LO**	Maximum (Benefit)
Financial leverage	**FICA**	Minimum (Cost)
Cash rate	**NO**	Maximum (Benefit)
Return on equity	**ÖK**	Maximum (Benefit)

The year 2023 is not included in the assessment since the annual balance sheet period for 2023 is still in progress. The data used in the study were obtained from the Public Disclosure Platform (KAP) and https://fintables.com/ websites. For 2022, the decision matrix was formed according to the values obtained from the financial statements and annual reports. While considering the alternatives used in the study, electric energy enterprises in the "BIST 100" and "BIST ELECTRIC" indices were taken into consideration.

The companies included in the scope of the research are given in Table 2.

Table 2. Enterprises in the scope of the research

Enterprise code	Enterprise name
ENJSA	Enerjisa energy
IZENR	Izdemir energy
ZOREN	Zorlu energy
ODAS	Odaş electric
TATEN	Sweetpinar energy
AKFYE	Akfen renewable energy
AKSEN	Aksa energy
ALFAS	Alfa solar energy
CWENE	CW energy
GWIND	Galata wind energy
SMRTG	Smart solar energy

Table 3 presents a decision matrix representing the calculated ratios of the enterprises for 2022.

Table 3. Decision matrix

Alternative/criteria	FAKA	NK	CO	LO	FICA	NO	ÖK
ENJSA	0.11	0.13	0.71	0.65	0.70	0.27	0.35
IZENR	0.27	0.17	1.03	0.18	0.29	0.02	0.54
ZOREN	0.18	0.001	0.60	0.58	0.74	0.13	0.006
ODAS	0.40	0.37	1.43	1.22	0.44	0.50	0.36
TATEN	0.40	0.47	0.95	0.95	0.60	0.91	0.33
AKFYE	0.63	0.28	0.60	0.60	0.61	0.38	0.10
AKSEN	0.12	0.11	1.43	1.40	0.43	0.16	0.24
ALFAS	0.17	0.24	1.67	1.20	0.51	0.84	0.57
CWENE	0.19	0.19	1.14	0.78	0.69	0.21	0.65
GWIND	0.83	0.64	8.52	8.49	0.21	6.85	0.21
SMRTG	0.135	0.11	1.34	1.07	0.70	0.17	0.32

4. RESULTS AND EVALUATION

Entropy and WASPAS were applied respectively. The results obtained were evaluated.

After the decision matrix was created, the Entropy method was applied to determine the criteria weights to be used in the WASPAS method. Since there were no negative values in the decision matrix, the values were normalized as shown in Table 4 without the need for correction in the data set.

Table 4. Decision matrix normalized by entropy method

Normalized decision matrix							
Alternative/criteria	**FAKA**	**NK**	**CO**	**LO**	**FICA**	**NO**	**ÖK**
ENJSA	0.032	0.048	0.037	0.038	0.118	0.026	0.095
IZENR	0.079	0.063	0.053	0.011	0.049	0.002	0.147
ZOREN	0.052	0.000	0.031	0.034	0.125	0.012	0.002
ODAS	0.116	0.136	0.074	0.071	0.074	0.048	0.098
TATEN	0.116	0.173	0.049	0.055	0.101	0.087	0.090
AKFYE	0.183	0.103	0.031	0.035	0.103	0.036	0.027
AKSEN	0.035	0.041	0.074	0.082	0.073	0.015	0.065
ALFAS	0.049	0.089	0.086	0.070	0.086	0.080	0.155
CWENE	0.055	0.070	0.059	0.046	0.117	0.020	0.177
GWIND	0.242	0.236	0.439	0.496	0.035	0.656	0.057
SMRTG	0.039	0.041	0.069	0.063	0.118	0.016	0.087

The natural logarithm of each criterion was taken and the logarithm value was multiplied by its own value. After normalization, the Entropy value for each criterion is shown in Table 5.

Table 5. Entropy values for criteria

Alternative/criteria	**FAKA**	**NK**	**CO**	**LO**	**FICA**	**NO**	**ÖK**
ENJSA	-0.110	-0.146	-0.121	-0.124	-0.252	-0.095	-0.224
IZENR	-0.200	-0.174	-0.156	-0.048	-0.148	-0.012	-0.282
ZOREN	-0.155	-0.003	-0.107	-0.115	-0.260	-0.055	-0.010
ODAS	-0.250	-0.272	-0.192	-0.188	-0.193	-0.146	-0.228
TATEN	-0.250	-0.304	-0.148	-0.160	-0.232	-0.213	-0.216
AKFYE	-0.311	-0.234	-0.107	-0.117	-0.234	-0.121	-0.098
AKSEN	-0.117	-0.130	-0.192	-0.205	-0.190	-0.064	-0.178
ALFAS	-0.149	-0.215	-0.211	-0.186	-0.211	-0.203	-0.289
CWENE	-0.160	-0.186	-0.166	-0.141	-0.251	-0.079	-0.306
GWIND	-0.343	-0.341	-0.361	-0.348	-0.118	-0.276	-0.164
SMRTG	-0.127	-0.130	-0.184	-0.173	-0.252	-0.067	-0.213

Using the formula k=1/ln(m), the entropy coefficient was found to be k=0.417. Here, m is the number of decision alternatives and k is a fixed number. E_j values are calculated using equation (3) and results are given in Table 5. Then, dj deviation values were obtained for each criterion by subtracting 1 from the E_j value. In the last stage, wj weight values were obtained as shown in Table 6 to determine the importance level of the criteria.

Table 6. Criteria weights

Criteria	**FAKA**	**NK**	**CO**	**LO**	**FICA**	**NO**	**ÖK**
E_j	0.906	0.890	0.812	0.753	0.977	0.554	0.921
d_j	0.094	0.110	0.188	0.247	0.023	0.446	0.079
w_j	**0.079**	**0.093**	**0.158**	**0.208**	**0.019**	**0.376**	**0.067**

The ranking of the importance of the criteria according to the weights (w_j) obtained as a result of the application of the entropy method is as follows: NO>LO>CO>NK>FAKA>ÖK>FICA.

In Figure 2, the criteria and criteria weights with the largest share are expressed as percentages.

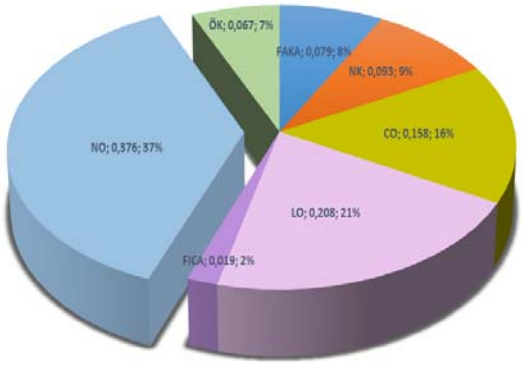

Figure 2. Pie chart showing criteria weights

In short, according to the results of the entropy method, the most important financial performance criterion is Cash Ratio and the second most important performance criterion is Liquidity Ratio. Financial Leverage, which has the lowest weight, is determined as a low impact criterion.

The criteria whose weights are calculated in Table 6 are used in the WASPAS method. WASPAS method will be used to evaluate the financial performance of electric energy enterprises.

In the first stage of the WASPAS method, the decision matrices need to be normalized as in the Entropy method. The decision matrices are normalized with the help of Equation (8) for the benefit criteria and Equation (9) for the cost criteria. In this context, Operating Profitability, Net Profitability, Current Ratio, Liquidity Ratio, Cash Ratio and Return on Equity are considered to benefit the business, while Financial Leverage is considered as a cost. Using the decision matrix, the decision matrix normalized according to the benefit and cost criteria is given in Table 7.

Table 7. Decision matrix normalized by waspas method

Normalized decision matrix							
Alternative/Criteria	**FAKA**	**NK**	**CO**	**LO**	**FICA**	**NO**	**ÖK**
ENJSA	0.133	0.203	0.083	0.077	0.300	0.039	0.538
IZENR	0.325	0.266	0.121	0.021	0.724	0.003	0.831
ZOREN	0.217	0.002	0.070	0.068	0.284	0.019	0.009
ODAS	0.482	0.578	0.168	0.144	0.477	0.073	0.554
TATEN	0.482	0.734	0.112	0.112	0.350	0.133	0.508
AKFYE	0.759	0.438	0.070	0.071	0.344	0.055	0.154
AKSEN	0.145	0.172	0.168	0.165	0.488	0.023	0.369
ALFAS	0.205	0.375	0.196	0.141	0.412	0.123	0.877
CWENE	0.229	0.297	0.134	0.092	0.304	0.031	1.000
GWIND	1.000	1.000	1.000	1.000	1.000	1.000	0.323
SMRTG	0.163	0.172	0.157	0.126	0.300	0.025	0.492

For the Weighted Sum Model (WSM), each alternative value was multiplied by the criterion weight values calculated in the Entropy method over the normalized decision matrix and the sum of each electric power enterprises was taken and the $Q_i^{(1)}$ value in Table 8 was obtained. In the next stage, the power of the criterion weight was taken for each alternative value over the normalized decision matrix for the Weighted Multiplication Model (WPM) and the values obtained were multiplied with each alternative respectively and the $Q_i^{(2)}$ value in Table 8 was obtained.

After obtaining $Q_i^{(1)}$ and $Q_i^{(2)}$ values within the scope of the Weight Sum and Multiplication model, the Weighted Common Overall Criteria value Q_i was calculated by taking (λ=0.5) with the help of equation (12). According to the value of Q_i, a ranking is presented in Table 8. The value with the highest Q_i was selected as the best alternative.

Table 8. Weighted common general criteria values and prioritization

Electric energy companies	$Q_i^{(1)}$	$Q_i^{(2)}$	Q_i	Sorting	Best performance
ENJSA	0.1150	0.0808	0.0979	9	GWIND (Galata wind energy)
IZENR	0.1444	0.0284	0.0864	10	
ZOREN	0.0558	0.0294	0.0426	11	
ODAS	0.2219	0.1601	0.1910	4	
TATEN	0.2379	0.1803	0.2091	2	
AKFYE	0.1642	0.1001	0.1321	5	
AKSEN	0.1310	0.0849	0.1080	7	
ALFAS	0.2241	0.1835	0.2038	3	
CWENE	0.1703	0.0929	0.1316	6	
GWIND	0.9546	0.9271	0.9409	1	
SMRTG	0.1279	0.0829	0.1054	8	

Looking at the priority ranking in Table 8, it is seen that Galata Wind Energy is the company with the best financial performance in 2022. Sweetpinar Energy, Alfa Solar Energy and Odaş Electric follow, respectively. Zorlu Energy ranked last in 2022 with a lower performance compared to other electricity energy enterprises, and Izdemir Energy ranked second to last. To summarize briefly, the financial performance ranking of energy enterprises in 2022 is as follows: Galata Wind Energy> Sweetpinar Energy> Alfa Solar Energy>Odaş Electric> Akfen Renewable Energy> CW Enerji> Aksa Energy> Smart Solar Energy> Enerjisa Energy> Izdemir Energy> Zorlu Energy.

In Figure 3, the performances of enterprises are ranked from largest to smallest.

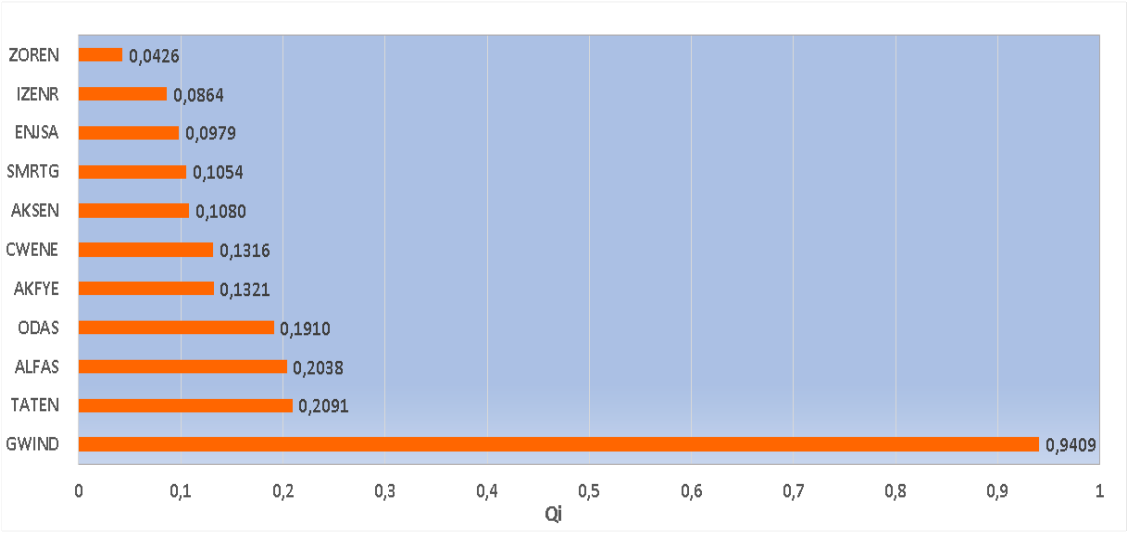

Figure 3. Financial performance ranking

In the application of the WASPAS method, the effect of different values of λ is examined in order to increase the accuracy in the decision-making process. Looking at the different values of (λ) in Table 9, it is observed that the degree of importance in the ranking does not change. For all (λ) values, Galata Wind Energy has the best financial performance.

Table 9. Overall total relative importance values of alternatives in 2022

2022	λ=0	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
ENJSA	0.081	0.084	0.088	0.091	0.095	0.098	0.101	0.105	0.108	0.112	0.115
IZENR	0.028	0.040	0.052	0.063	0.075	0.086	0.098	0.110	0.121	0.133	0.144
ZOREN	0.029	0.032	0.035	0.037	0.040	0.043	0.045	0.048	0.050	0.053	0.056
ODAS	0.160	0.166	0.172	0.179	0.185	0.191	0.197	0.203	0.210	0.216	0.222
TATEN	0.180	0.186	0.192	0.198	0.203	0.209	0.215	0.221	0.226	0.232	0.238
AKFYE	0.100	0.106	0.113	0.119	0.126	0.132	0.139	0.145	0.151	0.158	0.164
AKSEN	0.085	0.090	0.094	0.099	0.103	0.108	0.113	0.117	0.122	0.126	0.131
ALFAS	0.183	0.188	0.192	0.196	0.200	0.204	0.208	0.212	0.216	0.220	0.224
CWENE	0.093	0.101	0.108	0.116	0.124	0.132	0.139	0.147	0.155	0.163	0.170
GWIND	0.927	0.930	0.933	0.935	0.938	0.941	0.944	0.946	0.949	0.952	0.955
SMRTG	0.083	0.087	0.092	0.096	0.101	0.105	0.110	0.114	0.119	0.123	0.128

5. CONCLUSIONS

Performance evaluation is very important for electric energy enterprises. In order to increase their competitiveness and ensure their continuity, enterprises should regularly conduct performance evaluations. Financial performance is one of the leading factors to be taken into account in this evaluation process. Financial indicators such as revenues, expenses and profitability ratios of enterprises should be regularly monitored and analyzed. Analyzing the performance of enterprises in the energy sector within certain criteria and making the necessary improvements allows the current situation to be determined and thus more effective and efficient decision-making processes to be carried out.

Within the scope of the study, the performances of 11 electric power enterprises operating in Borsa Istanbul (BIST) were analyzed using their financial ratios for 2022. The 7 financial indicators determined to measure the performance of electric power enterprises are as follows: Operating Profitability, Net Profitability, Current Ratio, Liquidity Ratio, Financial Leverage, Cash Ratio, Return on Equity. In the analysis, the criteria were weighted using the Entropy method, one of the multi-criteria decision-making techniques, and then the financial performance of the enterprises was ranked using the WASPAS method. When the weights of the criteria selected according to the results of the Entropy method are analyzed, it is determined that the cash ratio is the most important criterion with a weight value of 0.376 and the financial leverage ratio is the lowest criterion with a weight value of 0.019. As a result of the weights obtained, it was determined that Galata Wind Energy had the highest performance with the application of the WASPAS method. In the same period, it was observed that Zorlu Energy had the lowest financial performance.

Based on the results of the analysis, it is very important for enterprises with low or medium financial performance to review their sales policies while making strategic decisions. In this process, it is important to gain competitive advantage by taking into account the performances of rival enterprises. In addition, electric power enterprises with low financial performance should strengthen their cash management by focusing more on the cash ratio criterion, which has the highest criterion weight. On the other hand, they should consider the financial leverage ratio criterion with the lowest criterion weight as a lower priority. Therefore, it is important for electric power enterprises with low financial performance to strengthen cash management and reduce debt burden as a priority. These strategies can be important steps towards improving their financial performance. Therefore, a comprehensive analysis and careful planning are necessary when making strategic decisions.

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