Performance evaluation of electricity generation companies traded on BIST according to the financial parameters through the application of TOPSIS method

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Abstract

Electrical energy is essential to the economic and social development and will improve the quality of life in any nation. Recently, a great deal of attention has been received and a fairly large body of literature has been focused on the TOPSIS method. In this study, the financial performance of 6 electricity generation companies whose shares are traded in the BIST are evaluated with multi decision making analysis by using financial ratios. The study conducted. NET framework coded in C# programming language.

Keywords: Electricity company; Performance Criteria; TOPSIS; BIST; C#.

1. Introduction

Energy is one of the most important components in developing countries. Energy plays a critical role in the economic growth, progress, and development, as well as poverty alleviation and security of any nation. Energy exists in many forms but the most important form is the electrical energy. Electrical energy can be easily converted into other forms of energy and transmitted from one place to another with the help of conductors. Electrical energy is essential to the economic and social development and will improve the quality of life in any nation.

The Turkish electricity sector is going through a rapid growth, mainly due to rising demand. Similar to the electricity sector, both consumption and generation of electricity is increasing as well. As reported by the Turkish Electricity Transmission Company (Turkiye Elektrik İletim A.S., TEIAS), the installed capacity in Turkey in 2014 was 69519,8 MW, while this figure rose by 5,2% in 2015, reaching 73146,7 MW. Turkey's installed power capacity stands today at around 75 GW and the aim is to have 100 GW of installed capacity by 2023. The total installed capacity is made up of The Electricity Generation Company (EUAS), independent power producers, the build-own-operate power plants, the build-own-operate-transfer power plants, the auto-producers and companies operating under transfer of operating rights agreements.

Power generation capacity has increased significantly. In 2015, total net electricity generation increased by 3% compared to 2014. The Turkish electricity generation is largely dominated by natural gas/LNG powered electric plants (37,8%), coal (lignite, imported coal and hard coal) powered plants (30%) and hydroelectric plants (25,8). Wind power plants constitute about 4,4% of total electricity generation in Turkey. Geothermal power plants accounted for 1,3% and biogas

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power plants 0,6%. The nuclear energy is not used yet as power generation resource in Turkey. But, Turkey intends to have it first nuclear power plant operating until 2023. Distribution of The Turkish electricity generation according to the sources is given in Figure 3 (TEIAS, 2015).
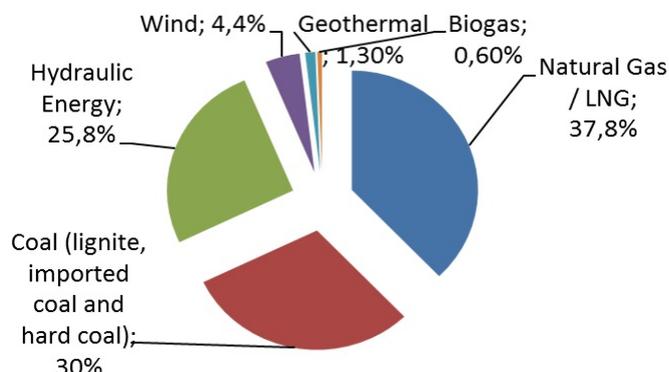

Figure 1. Distribution of the Turkish electricity generation (TEIAS, 2015).

The Turkish Electricity Authority (TEK) was established by the Electricity Market Law number 1312 issued in 1970. TEK was split into two state owned enterprises in 1993: one for generation and transmission, the Turkish Electricity Generation and Transmission Company (TEAS) and the other for distribution, the Turkish Electricity Distribution Company (TEDAS). TEAS was restructured to form three state-owned public enterprise, namely the Electricity Generation Corporation (EUAS), the Turkish Electricity Transmission Corporation (TEIAS), and the Turkish Electricity Trading and Contracting Corporation (TETAS) in 2003 upon the taking effect of the Electricity Market Law number 4628 (TEIAS, 2016). Turkey's distribution network was divided into 21 distribution regions within privatization based on the Electricity Sector Reform and Privatization Strategy Paper (OIB, 2004). TEIAS signed a Long Term Agreement with the continental European members of ENTSO-E on the permanent synchronous operations of the Turkish power system with Continental Europe synchronous area on 15 April 2015.

Recently, a great deal of attention has been received and a fairly large body of literature has been focused on the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. Financial ratio analysis is one of the most widely used fundamental analysis techniques. Feng and Wang (2000) investigated a performance evaluation process for Taiwan's five major airlines with financial ratios. They used the grey relation analysis to select the representative indicators and used the TOPSIS method. Yurdakul and İç (2003) used the TOPSIS method for the financial performance evaluation of five large-scale public companies that operates in the Turkish automotive industry. Wang (2008) implemented fuzzy multi-criteria decision making approach to evaluate financial performance of domestic airlines in Taiwan. Ertuğrul and Karakaşoğlu (2009) used a fuzzy multi-criteria decision making model for performance evaluation of Turkish cement firms by using some of the traditional accounting-based financial ratios. Dumanoğlu ve Ergül (2010) analyzed financial performances of 11 technology firms whose shares are traded on the Istanbul Stock Exchange (ISE) with the TOPSIS method by using financial statements for the period 2006-2009. Bülbül and Köse (2011) evaluated the financial performance of 19 Turkish food companies whose shares are traded on the ISE with multi decision making analysis by using financial ratios. See also Meydan et al. (2016), where authors evaluated financial performance of food companies traded on the ISE using Grey Relational Analysis. Uygurtürk and Korkmaz

(2012) analyzed financial performances of 13 basic metal industry enterprises whose shares are traded on the ISE with the TOPSIS method by using financial statements for the period 2006-2010. An application of evaluating the performance of 23 Greek manufacturing sectors with the use of financial data has been provided by Halkos and Tzeremes (2012). Mandic et al. (2014) proposed a fuzzy multi-criteria model that will facilitate the assessment of the financial performance of Serbian banks for the period between the years 2005 and 2010. In addition, financial performances of 7 tourism firms traded in the Borsa Istanbul (BIST) have been evaluated as to eight financial ratios including liquidity, leverage, profitability and activity indicators between the period 2010-2014 by Özçelik and Kandemir (2015). The main objective of this study is to evaluate the financial performance of 6 electricity generation companies whose shares are traded in the BIST with multi decision making analysis by using financial ratios. For this purpose, the TOPSIS method is used in this study.

The paper is organized as follows: The next section presents introduction of 6 electricity generation companies. The main idea of the TOPSIS method is outlined in section 3. Section 4 presents the financial performance of 6 electricity generation companies. Finally, the last section concludes the paper.

2. The electricity generation companies

In this paper, financial performances of 6 electricity generation companies whose shares are traded in the BIST are analyzed with the TOPSIS method by using financial ratios for 2015. The information of financial ratios calculation used was derived from the annual financial statements published on BIST (2016), Public Disclosure Platform (KAP, 2016) and Bigpara (2016) websites. The electricity generation companies studied are shown in Table 1.

Table 1. The electricity generation companies.

	BIST Share Name	**Company Name**
A_1	AKENR	Akenerji Electricity Generation Inc.
A_2	AKSEN	Aksa Energy Generation Inc.
A_3	AKSUE	Aksu Energy and Trade Inc.
A_4	AYEN	Ayen Energy Inc.
A_5	ODAS	Odas Electricity Generation Industry and Trade Inc.
A_6	ZOREN	Zorlu Energy Electricity Generation Inc.

3. TOPSIS

The TOPSIS is a multi-criteria decision technique. This technique is developed by Hwang & Yoon (1981). According to this method solution is calculated using Euclidian distance formula between positive and negative ideal solution of criteria. Performance of alternative is determined with nearest to positive ideal solution and farthest to negative ideal solution. The positive ideal solution has the maximum value of benefit criteria, minimum value of cost criteria (Equation 5). The negative ideal solution has the maximum value of cost criteria; minimum value of benefit criteria (Equation 6) Table 2 shows the structure of a type of multiple criteria decision problem.

Table indicate that alternative which is denoted *i=1,2,…,m;* criteria *j:1,2,…n;* x_{ij} value demonstrate the criteria performances of alternative (Yu et all., 2011).

Table 2. A type of multiple-criteria decision problem.

	Criterion 1	Criterion 2	…	Criterion n
Alternative 1	x_{11}	x_{12}	…	x_{1n}
Alternative 2	x_{21}	x_{12}	…	x_{2n}
…	…	…	x_{ij}	…
Alternative m	x_{m1}	x_{12}	…	x_{mn}

Figure 2. Flow chart of TOPSIS method.
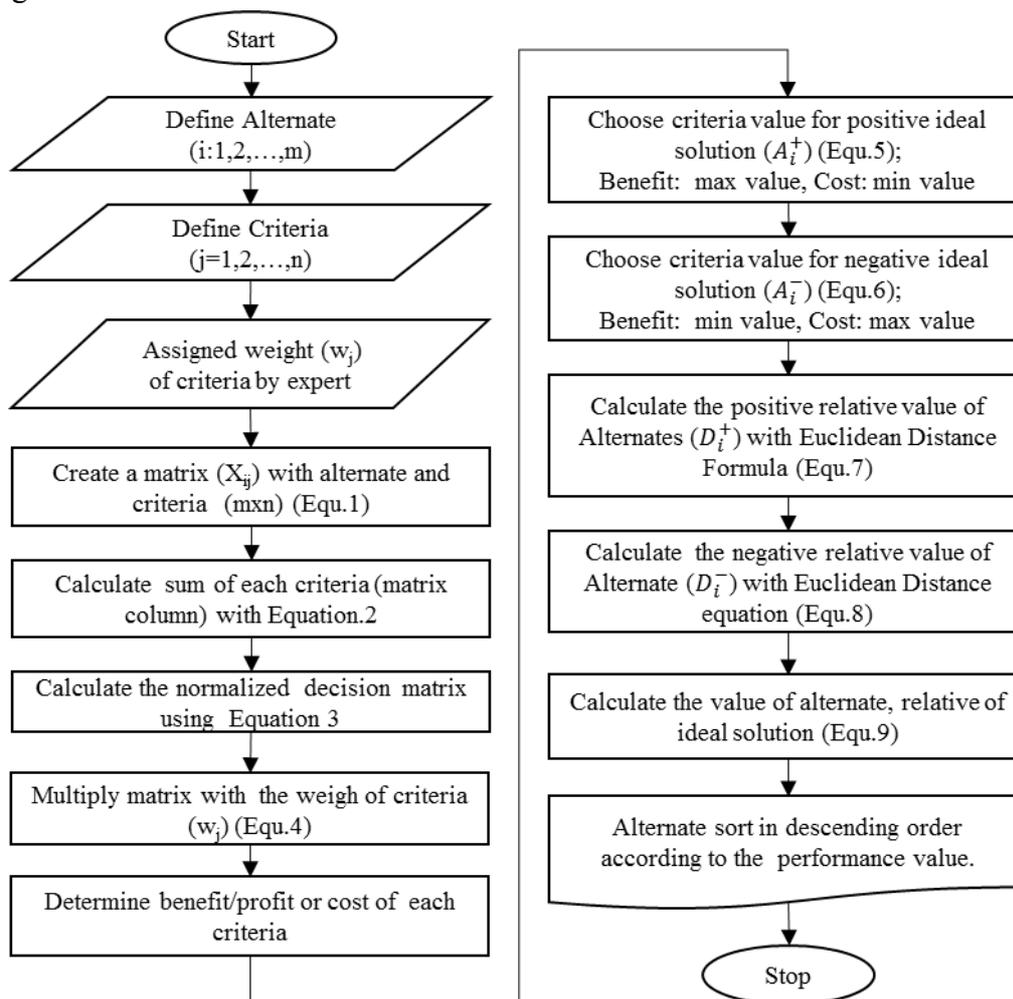
Flow chart of TOPSIS method's calculation steps are shown in Figure 2. Alternative whose performances are to be compared are defined. The criteria of alternatives are defined. A matrix of alternative and criteria are formed and data is set (Equation1). Then matrix is normalized with each of values in column are divided to sum of respective matrix column (Equation2, 3).

$$X_{ij} = \begin{array}{c} \\ A_1 \\ \vdots \\ A_m \end{array} \overset{\begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array}}{\begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ \vdots & & X_{ij} & \vdots \\ X_{m1} & X_{m2} & \cdots & X_{mn} \end{bmatrix}} \quad (i = 1,2,\dots,m ; \quad j = 1,2,\dots,n) \tag{1}$$

$$Y_i = \sqrt{\sum_{i=1}^{m}(X_{ij})^2} \tag{2}$$

$$R_{ij} = \frac{X_{ij}}{Y_i} \quad (i = 1,2,\dots,m ; \quad j = 1,2,\dots,n) \tag{3}$$

Weight values of criteria are assigned by an expert. Weight values must be between 0 and 1 ($0<w_j<1$). Sum of criteria weight values must be 1. Equation 4 is acquired by multiplying weight values and respective criteria of alternative ($V_{ij} = w_i * R_{ij}$).

$$V_{ij} = \begin{bmatrix} w_1 R_{11} & w_2 R_{12} & \cdots & w_1 R_{1n} \\ \vdots & & \ddots & \vdots \\ w_1 R_{m1} & w_2 R_{n2} & \cdots & w_n R_{mn} \end{bmatrix} \quad (i = 1,2,\dots,m ; \quad j = 1,2,\dots,n) \tag{4}$$

The positive ideal value (A_i^+) is maximum value of benefit criteria, minimum value of cost criteria (Equation 5). The negative ideal solution is maximum value of cost criteria, minimum value of benefit criteria (Equation 6).

$$A_i^+ = \begin{cases} Max(V_{ij}), & Benefit, \ j \in J , \ i = 1,2,\dots,m \\ Min(V_{ij}), & Cost, \quad j \in J, \ i = 1,2,\dots,m \end{cases} \tag{5}$$

$$A_i^- = \begin{cases} Min(V_{ij}), & Benefit, \ j \in J, \ i = 1,2,\dots,m \\ Max(V_{ij}), & Cost, \quad j \in J, \ i = 1,2,\dots,m \end{cases} \tag{6}$$

Distance of alternative from positive and negative ideal solution is calculated using Euclidean Distance Formula (Equation 7, 8). Performances of alternatives are determined according to relative proximity to positive and negative ideal solution (Equation 9). D_i being greater indicates that the relevant alternative is closer to positive ideal solution (Aktaş et al., 2015). If $D_i = 1$ then alternate is point of positive ideal solution and if $D_i = 0$ then alternate is point of negative ideal solution (Özdağoğlu, 2013).

$$D_i^+ = \sqrt{\sum_{j=1}^{n}(V_{ij} - A_j^+)^2} \quad (i = 1,2,\dots,m ; \quad j = 1,2,\dots,n) \tag{7}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n}(V_{ij} - A_j^-)^2} \quad (i = 1,2,\dots,m ; \quad j = 1,2,\dots,n) \tag{8}$$

$$D_i = \frac{D_i^-}{D_i^- + D_i^+} \quad ; \ 0 \le D_i \le 1 \ ; \quad (i = 1,2,\dots,m) \tag{9}$$

4. Financial performance of companies

Performances of companies operating in electrical energy production field and transacted in Istanbul stock Exchange are evaluated according to economic data using TOPSIS. At the date this study was conducted performances of these six companies (AKENER, AKSEN, AKSUE,

AYEN, ODAS, ZOREN) (See Table 1) where calculation economic data in 2015 Where calculated using economical data. Acknowledged company evaluation method was used as performance criteria is shown in Table 3) (Aytekin and Sakarya, 2013). The data used in this study were acquired from KAP (2016) and BIGPARA (2016) web pages. Twelve different criteria were used to assess the company performances. The criteria were dived to two groups according to their contribution to performance as profit and cost. Since C_1, C_3, C_4, C_5, C_6, C_7, C_8, C_{10} criteria values are designated as benefit, they contribute positively, and C_2, C_9, C_{11}, C_{12} criteria values are designated as cost, they affect performance negatively. Current rate (C_9) criterion value was designated as absolute distinct from the average of sector (Table 4). Distinct value is to be calculated as absolute value as it gains distance from average, positive contribution C_9 is to decrease as a result C_9 value is to be calculated as cost.

Table 3. Description of criteria

Denote	Criterion	Contribution
C_1	Price-Earnings Ratio: An In-Depth Guide	Benefit
C_2	Pprice-To-Book Ratio: Market Value	Cost
C_3	Net Profit / Total Assets ratio: Return On Assets	Benefit
C_4	Net Profit / equity ratio : Return On Equity	Benefit
C_5	Market Value / Net Sales Ratio	Benefit
C_6	Market Value / Operating Profit Ratio	Benefit
C_7	Net Profit/Net Sales Ratio	Benefit
C_8	Operating Profit / Net Sales Ratio	Benefit
C_9	Current Rate (absolute distinct from the average of sector)	Cost
C_{10}	Operating Profit / Short Term Debt Ratio	Benefit
C_{11}	Short Term Debt / Total Assets Ratio	Cost
C_{12}	Short Term Debt / Total Debt Ratio	Cost

Data used in this study is placed in Table 5 as illustrated. Companies (alternatives-A_i) are indicated with *i* and criteria as *j*. Mathematically it can be stated as in Equation 1. The flow chart in Figure 2 is to be initiated, alternatives, criteria and coefficients of the alternatives are assigned and then placed as illustrated in Table 4 and TOPSIS calculation process is initiated. Sum of criteria value squares are squared (Y_i) (Equation 2). It shows that last two rows in Table 4. As in Equation 3 every element of the matrix are normalized. After this process a measure is acquired as [0,1] unchanging the ratio of data(Table 6).

Table 4. Performance criteria values of Energy Production Companies transacted in BIST

	Alternative					
	A_1	A_2	A_3	A_4	A_5	A_6
C_9 criteria value	0,5	0,58	4,42	0,82	0,80	0,33

$C_{9\_mean} = 7,45$; which is arithmetic mean of C_9

$C_{9\_n}=|C_{9\_mean} - C_9|$	0,742	0,662	3,178	0,422	0,422	0, 912

Table 5. Performance criteria values of Energy Production Companies transacted in BIST

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_{9_n}	C_{10}	C_{11}	C_{12}
A_1	0	1,52	-0,1	-0,63	0,69	-14,15	-0,29	-0,05	0,742	-0,09	0,19	0,22
A_2	41,32	1,16	0,01	0,04	0,84	7,36	0,02	0,11	0,662	0,24	0,26	0,38
A_3	0	1,88	-0,03	-0,03	39,97	-369,24	-0,72	-0,11	3,178	-0,2	0,02	0,09
A_4	12,75	1,42	0,02	0,11	1,49	7,19	0,12	0,21	0,422	0,15	0,22	0,27
A_5	14,57	1,25	0,04	0,09	0,6	7,61	0,04	0,08	0,422	0,28	0,25	0,46
A_6	0	1,88	-0,05	-0,42	1,23	21,5	-0,28	0,06	0,912	0,02	0,39	0,44
Sum(Y_i)	2072,287	14,304	0,016	0,596	1602,876	137164,428	0,697	0,081	12,294	0,207	0,367	0,679
Sqrt(Y_i)	45,522	3,782	0,124	0,772	40,036	370,357	0,835	0,284	3,506	0,455	0,606	0,824

Table 6. Normalized table

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
A_1	0	0,402	-0,806	-0,816	0,017	-0,038	-0,347	-0,176	0,212	-0,198	0,314	0,267
A_2	0,905	0,307	0,081	0,052	0,021	0,02	0,024	0,387	0,189	0,527	0,429	0,461
A_3	0	0,497	-0,242	-0,039	0,998	-0,997	-0,862	-0,387	0,906	-0,44	0,033	0,109
A_4	0,28	0,375	0,161	0,142	0,037	0,019	0,144	0,739	0,120	0,33	0,363	0,328
A_5	0,32	0,331	0,323	0,117	0,015	0,021	0,048	0,282	0,126	0,615	0,413	0,558
A_6	0	0,497	-0,403	-0,544	0,031	0,058	-0,335	0,211	0,260	0,044	0,644	0,534

According to the opinion of an expert, criteria are assigned with w_i weight values. Sum of criteria weight values must be equal to 1 (($\sum_{j=1}^{n} w_j$ =1). In this study, all criteria are assigned with equal weight values. Weight values of every criterion are designated as $w_i=1/number\_of\_criteria$ *(1/12)*. By multiplying criterion weight values with normalized values, weighted vector (Equation 4) is acquired (Table 7).

Table 7. Vector table which is weighted according to w_j weight value

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
A_1	0	0,033	-0,067	-0,068	0,001	-0,003	-0,029	-0,015	0,018	-0,016	0,026	0,022
A_2	0,075	0,025	0,007	0,004	0,002	0,002	0,002	0,032	0,016	0,044	0,036	0,038
A_3	0	0,041	-0,02	-0,003	0,083	-0,083	-0,072	-0,032	0,075	-0,037	0,003	0,009
A_4	0,023	0,031	0,013	0,012	0,003	0,002	0,012	0,061	0,010	0,027	0,03	0,027
A_5	0,027	0,027	0,027	0,01	0,001	0,002	0,004	0,023	0,010	0,051	0,034	0,046
A_6	0	0,041	-0,033	-0,045	0,003	0,005	-0,028	0,018	0,022	0,004	0,053	0,044

Table 8. Positive and negative ideal values of criteria according to benefit/cost features

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
A_i^+	0,075	0,041	0,027	0,012	0,083	0,005	0,012	0,061	0,001	-0,037	0,003	0,009
A_i^-	0	0,025	-0,067	-0,068	0,001	-0,083	-0,072	-0,032	0,075	0,051	0,053	0,046

In the next stage, ideal positive (A_i^+) and ideal negative (A_i^+) values are calculated in respect of benefit and cost of criteria to solution. C_1-C_8 criteria are benefit, C_9-C_{12} criteria are cost and according to Equation 5, for ideal positive, benefit criteria must be maximum and cost criteria minimum, for ideal negative according to Equation 6, benefit criteria must be minimum whereas cost criteria must be maximum. As an example; C_2 criterion in Table 6 is profit and to find the ideal positive, highest value of C_2 column 0.041 is used. Similarly, to find the ideal negative for C_2 lowest value of the column, 0.025 is used. By doing this, positive and negative ideal values of every criterion are acquired (Table 8).

Table 9. The weight of criteria

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
W_1	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12	1/12
W_2	0,1	0,1	0,1	0,075	0,075	0,075	0,075	0,1	0,075	0,075	0,075	0,075

Table 10. Distance value of alternative from ideal positive and negative

Alternative	Companies	W_1			W_2		
		D_i^+	D_i^-	Performance	D_i^+	D_i^-	Performance
A_1	AKENR	0,201	0,117	0,368	0,215	0,106	0,333
A_2	AKSEN	0,100	0,209	0,676	0,095	0,214	0,693
A_3	AKSUE	0,209	0,130	0,383	0,216	0,124	0,365
A_4	AYEN	0,105	0,213	0,670	0,104	0,218	0,677
A_5	ODAS	0,114	0,210	0,648	0,115	0,210	0,646
A_6	ZOREN	0,169	0,136	0,446	0,176	0,131	0,427

Table 11. Performance order of alternatives different weight according to proportional values of positive and negative ideal

W_1			W_2		
Order #	Alternative	Performance	Order #	Alternative	Performance
1	AKSEN	0,676	1	AKSEN	0,693
2	AYEN	0,670	2	AYEN	0,677
3	ODAS	0,648	3	ODAS	0,646
4	ZOREN	0,446	4	ZOREN	0,427
5	AKSUE	0,383	5	AKSUE	0,365
6	AKENR	0,368	6	AKENR	0,330

In weighted table (Table 7) relative deviation of every criterion to ideal positive and negative (Table 8) are calculated using Euclidian distance formula (Equation 7 and 8).

D_i^+ is the deviation from positive ideal and, D_i^- is the deviation from negative ideal solution. In Table 8, distance calculations of ideal positive and negative solutions are done. Later in the study, relative distance from ideal positive and negative solution is calculated (Equation 9) and performance values are acquired. Performance is calculated different weight values (Table 9). Two different weight's performance values of Table 10 is illustrated in descending order in Table 11. According to this order, company with the best performance is AKSEN, worst is AKENR. AYEN close to AKSEN, and AKSUE close to AKENR.

5. Conclusions and recommendations

Companies engaged in electricity energy generation, traded in the Borsa İstanbul, are evaluated according to the acknowledged evaluation criteria. TOPSIS performance evaluation method is used since this is a multi-criteria decision problem. Six companies are listed in descending order according to 2015 economic data criteria and company performance. As a result, company with the best performance was AYEN, and the company with the worst performance was AKENER.

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In this study, a software which can create solutions according to TOPSIS method was developed using C#.Net. Problem was solved through the use of the developed program. Software has the flexibility to be used in similar studies.

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