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Assessing the performance of metal industry companies using novel hybrid MEREC-WASPAS methods

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Abstract **–** Business managers all over the world are tackling a variety of shifts in organizations that have a substantial influence on structures, processes, and people in addition to economic volatility, geopolitical unpredictability, and the COVID-19 pandemic's long-lasting repercussions. Managers should already be trying to increase their company's revenue in 2023 compared to the previous year. The COVID-19 epidemic and other recent disruptions have demonstrated how brittle business performance is. As a result, corporations have begun to evaluate their performance with less enthusiasm. To handle the performance analysis problem for ISO500 companies in the metal industry, a novel integrated decision-making model that takes into account some key indicators is developed. This model is based on MEREC for computing the criteria weights and the WASPAS technique for evaluating the alternatives. An example of the metal industry is considered to demonstrate the validity and applicability of the suggested method. The 20 companies are evaluated using the developed methodology. The İskenderun Demir ve Çelik A.Ş. company was found to be the best choice for performance assessment of companies. Regarding key indicators, exports, and equity capital, İskenderun Demir ve Çelik A.Ş. is in a very favorable position. Sensitivity analysis tests are run in order to show the robustness of the results.

Keywords – ISO500, MEREC, Metal Industry, Performance Assessment, WASPAS.

I. INTRODUCTION

The development and growth of nations' economies globally are greatly influenced by the metal sector [1]. It includes a wide range of subsectors, including manufacturing machinery, the production of iron and steel, and metal fabrication [2]. In Turkey, the metal sector occupies a significant space in the nation's industrial structure. The performance of metal sector companies has become a topic of considerable attention and importance as one of the major contributors to Turkey's economy [3], [4].

Due to the complexity of their operations and the large number of performance indicators involved [5], metal sector organizations' performance must be evaluated and benchmarked. These companies must be thoroughly evaluated using a methodical, rigorous methodology that takes into consideration different factors and gives them the right degree of weight [6].

The use of multi-criteria decision-making (MCDM) techniques offers an excellent basis for evaluating and rating businesses according to several performance metrics. By taking into account a number of variables, many of which are multi-dimensional and frequently contradictory in nature, these strategies take into account the inherent complexity of choice problems [7]. The use of MCDM methodologies enables a more thorough and precise evaluation of business performance by integrating multiple factors.

Within the framework of MCDM approaches, we use a novel hybrid MEREC-WASPAS (Multicriteria Evaluation based on Ratio Analysis and Weighted Aggregated Sum Product

Assessment) methodology in this study. By taking into account a wide range of performance indicators, such as financial metrics, production volumes, employment figures, and trade information, this methodology enables us to methodically analyze the success of metal industry companies.

The MEREC-WASPAS method allows for a thorough evaluation that takes into consideration both financial and non-financial performance criteria by combining the benefits of ratio analysis and weighted aggregated sum product assessment. We can capture the relative importance of various elements by giving each criterion the proper weights, and we can then adjust the evaluation procedure to the unique circumstances of the metal business.

We want to create a company ranking model using MCDM approaches that offers stakeholders, investors, and decision-makers useful information about the performance of metal industry companies. The model provides a more comprehensive evaluation and lowers the possibility of biased or insufficient assessments by incorporating various criteria and their interdependencies.

Enhancing decision-making processes, promoting transparency, and fostering sustainable growth are all potential benefits of using MCDM methodologies into the performance evaluation of metal industry companies. It helps stakeholders to make knowledgeable decisions based on a thorough understanding of a company's performance across many dimensions, ensuring a more thorough and impartial assessment.

We will describe the research methods in this section, then show the findings of our analysis and talk about their consequences. We provide an important boost to the field of performance evaluation in the metal sector by using MCDM methodologies, notably the hybrid MEREC-WASPAS methodology. Our study serves as a resource for academics, professionals, and decision-makers who are interested in implementing thorough and rigorous methodologies to evaluate corporate performance in this industry.

II. Literature Review

Vincent and Hu [5] created an integrated MCDM method that combines the voting method with the fuzzy TOPSIS method to assess the performance of numerous manufacturing facilities in a fuzzy environment. A case study illustrating the use of the suggested model is provided. Ersoy [8] used TOPSIS, MAUT, and SAW methodologies from MCDM techniques to compare the performance measurement of 8 businesses that operate in the e-commerce sector and are listed among the top 500 companies by "Fortune TURKEY" magazine during the 2010–2014 period. Ünvan [9] provided an evaluation model based on six factors for the companies in the ISE30 index in terms of returns and analyzed with TOPSIS method. Abdel-Basset et al. [6] developed a plithogenic MCDM model based on neutrosophic AHP, VIKOR method, and TOPSIS method. The top 10 steel businesses in Egypt are assessed using specific financial ratios to examine the suggested model. Lukić [10] examined the effectiveness of pharmaceutical enterprises in Serbia (involved in the manufacturing and distribution of pharmaceutical products, or just distribution) with the CODAS method. Gupta et al. [11] measured the financial performances of selected Indian private banks by an integrated AHP-TOPSIS methodology. Kumaran [12] ranked IPO firms using a combined approach of the objective weighting method (CRITIC) and the MCDM technique (VIKOR), evaluating their performance in the "pre- and post-IPO period" using accounting and value-based financial measures. Ahmad et al. [13] specified green-lean performance drivers to classify identified SMEs into different classes and rank the drivers for the Indian SMEs using best-worst method (BWM).

III. Research Methodology

In this study, the criteria are weighted, and the alternatives are ranked using the MEREC and WASPAS methods, respectively. The steps of the methods are given as follows:

A. MEREC Method

Step 1: Develop the decision matrix.
Step 2: Normalize the decision matrix.
Step 3: Determine the alternatives' overall performance.
Step 4: Compute the performance of the alternatives by subtracting each criterion.
Step 5: Find the summation of absolute deviations.
Step 6: Establish the criteria's final weights.

B. WASPAS Method

Step 1: Construct the decision matrix.
Step 2: Normalize the decision matrix.

Step 3: Calculate the total relative importance of alternatives based on WSM method.
Step 4: Calculate the total relative importance of alternatives based on WPM method.
Step 5: Compute a combined optimality value.
Step 6: Rank the alternatives.

IV. ASSESSMENT OF THE METAL INDUSTRY COMPANIES' PERFORMANCES

In this performance assessment study, hybrid MEREC-WASPAS methodologies were used to examine the performance of primary metal industry businesses in the ISO500 ranking. The ISO500 website (https://www.iso500.org.tr/500-buyuk-sanayi-kurulusu) provided the data set for the year 2021, which included the ratio and share prices of the companies considered in the study. Due to inadequate data, certain companies were removed from the analysis.

Seven metrics, net sales, gross value added, equity, assets total, profit/loss before tax, export (1000$), number of employees, and summarized data for 20 companies are available for investigation.

After the implementation of the MEREC method steps, the weights of metrics are calculated and as given in Figure 1. The WASPAS approach is used to determine the companies' performance after the criterion weights were established. Using the year 2021 decision matrix in Table 1, the steps of the WASPAS method are applied and the rankings given in Table 2 are obtained.

V. CONCLUSION

Companies are frequently faced with unexpected disruptive events such as COVID-19 and economic crises, and they need to measure the performance of their resources to be successful in competition. The major goal of this study is to analyze the performance of ISO500 primary metal industry enterprises using the hybrid MCDM model based on MEREC and WASPAS techniques. The results of 20 companies on the 2021 ISO500 list were investigated from this angle in this study. Since there is no need to evaluate decision-makers subjectively while determining criterion weights, the MEREC method has been favored. However, due to its simplicity and ease of use, the WASPAS technique was chosen.

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Table 1. The dataset for the analysis

	Net Sales (C1)	Gross value added (C2)	Equity (C3)	Assets total (C4)	Profit/loss before tax (C5)	Export (1000 $) (C6)	Number of employees (C7)
	(+)	(+)	(+)	(+)	(-)	(+)	(+)
İskenderun Demir ve Çelik A.Ş.	38.669.497.386,00	38.690.799.645,00	17.643.659.529,00	2,94	3,04	831.417,00	4768
Ereğli Demir ve Çelik Fabrikaları T.A.Ş.	36.787.827.783,00	52.659.491.553,00	10.273.560.715,00	4,13	3,84	630.933,00	6109
İçdaş Çelik Enerji Tersane ve Ulaşım Sanayi A.Ş.	25.762.339.864,00	25.763.375.155,00	2.728.037.461,00	0,84	0,48	1.346.732,00	4914
Sarkuysan Elektrolitik Bakır San. ve Tic. A.Ş.	13.224.459.206,00	13.399.018.519,00	1.404.039.890,00	0,45	0,30	714.287,00	836
Kaptan Demir Çelik Endüstrisi ve Ticaret A.Ş.	6.994.769.605,00	7.097.316.188,00	708.508.258,00	0,53	0,27	614.179,00	996
Borusan Mannesmann Boru San. ve Tic. A.Ş.	6.000.221.049,00	6.133.809.968,00	1.654.342.075,00	0,18	0,04	237.066,00	1526
Posco Assan TST Çelik Sanayi A.Ş.	5.546.529.915,00	5.553.369.907,00	1.452.649.450,00	0,05	0,12	162.887,00	498
Erdemir Çelik Servis Merkezi San. ve Tic. A.Ş.	5.407.379.168,00	8.361.665.714,00	475.682.785,00	0,36	0,22	93.193,00	308
Mescier Demir Çelik San. ve Tic. A.Ş.	4.165.440.897,00	4.644.608.219,00	646.590.272,00	0,36	0,18	331.993,00	1039
Kocaer Çelik San. ve Tic. A.Ş.	4.064.128.692,00	4.266.725.902,00	841.718.245,00	0,40	0,23	275.414,00	694
Döktaş Dökümcülük Tic. ve San. A.Ş.	2.850.632.670,00	2.959.186.786,00	271.107.164,00	0,26	0,17	241.553,00	2682
Çebitaş Demir Çelik Endüstrisi A.Ş.	2.277.719.587,00	2.282.172.790,00	349.989.084,00	0,39	0,24	19.333,00	292
Sarbak Metal Tic. ve San. A.Ş.	2.244.783.687,00	2.246.156.977,00	480.201.082,00	0,40	0,22	107.662,00	286
Özer Metal Sanayi A.Ş.	1.886.335.435,00	1.886.335.435,00	624.927.739,00	0,47	0,29	89.573,00	125
ÇEMTAŞ Çelik Makina San. ve Tic. A.Ş.	1.691.521.200,00	1.742.303.826,00	725.417.635,00	0,47	0,28	57.883,00	469
Akpa Alüminyum San. ve Tic. A.Ş.	1.426.488.564,00	1.667.428.700,00	288.705.624,00	0,39	0,23	61.865,00	808
Tufan Endüstri Demir Çelik San. ve Tic. A.Ş.	1.407.179.558,00	1.444.524.035,00	92.216.563,00	0,32	0,20	10.027,00	118
Trakya Döküm San. ve Tic. A.Ş.	1.375.373.356,00	1.418.329.217,00	557.495.313,00	0,34	0,20	47.061,00	1115
ERBOSAN Erciyas Boru San. ve Tic. A.Ş.	1.278.468.417,00	1.328.349.832,00	285.876.289,00	0,40	0,24	77.099,00	312
Niğdelioğlu Metal Döküm İnşaat San. ve Tic. Ltd. Şti.	1.102.962.644,00	1.102.962.645,00	52.829.906,00	0,34	0,21	1.814,00	70

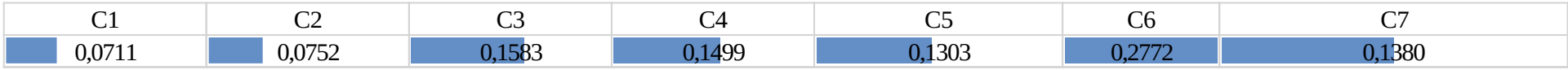

Fig. 1. The weights of metrics

Table 2. The ranking of companies

	Rank

İskenderun Demir ve Çelik A.Ş.	0,7676	1
Ereğli Demir ve Çelik Fabrikaları T.A.Ş.	0,7622	2
İçdaş Çelik Enerji Tersane ve Ulaşım Sanayi A.Ş.	0,4720	3
Sarkuysan Elektrolitik Bakır San. ve Tic. A.Ş.	0,2159	4
Kaptan Demir Çelik Endüstrisi ve Ticaret A.Ş.	0,1779	5
Borusan Mannesmann Boru San. ve Tic. A.Ş.	0,1076	9
Posco Assan TST Çelik Sanayi A.Ş.	0,0725	10
Erdemir Çelik Servis Merkezi San. ve Tic. A.Ş.	0,0684	11
Mescier Demir Çelik San. ve Tic. A.Ş.	0,1178	6
Kocaer Çelik San. ve Tic. A.Ş.	0,1084	8
Döktaş Dökümcülük Tic. ve San. A.Ş.	0,1108	7
Çebitaş Demir Çelik Endüstrisi A.Ş.	0,0388	18
Sarbak Metal Tic. ve San. A.Ş.	0,0601	12
Özer Metal Sanayi A.Ş.	0,0563	15
ÇEMTAŞ Çelik Makina San. ve Tic. A.Ş.	0,0588	13
Akpa Alüminyum San. ve Tic. A.Ş.	0,0550	16
Tufan Endüstri Demir Çelik San. ve Tic. A.Ş.	0,0234	19
Trakya Döküm San. ve Tic. A.Ş.	0,0572	14
ERBOSAN Erciyas Boru San. ve Tic. A.Ş.	0,0489	17
Niğdelioğlu Metal Döküm İnşaat San. ve Tic. Ltd. Şti.	0,0176	20