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A hybrid framework for evaluating corporate sustainability using multi-criteria decision making

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Abstract
Firms have to improve sustainable processes and carry out performance measurement in today's competitive environment as well as optimize their business processes. Corporate sustainability which is the definition of sustainable development on the business scale not only focuses on corporates' profitability, but also takes into account the environmental and social improvements. In this study, an approach based on a hybrid multi-criteria decision-making (MCDM) method is proposed in order to help firms to evaluate the degree of achieving their economic, environmental, and social goals. Entropy method is used to find out criteria weightings, and then VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje), TOPSIS (the Technique for Order Preference by Similarity to Ideal Solution), and MAUT (Multi-Attribute Utility Theory) methods are implemented with the help of the weights obtained to define performance ranking of alternative sustainability reports. Lastly, a combined ranking is obtained by utilizing the three rankings of the mentioned methods via the Borda count method, which is a data fusion technique. By performing a real case of sustainability performance evaluation of a furniture company, it is aimed to assist decision-makers in making integrated decisions for their sustainability performance and improving their activities in terms of sustainability. The results show that VIKOR and MAUT have the same ranking list for economic and environmental dimensions, whereas they produce different results in terms of social dimension. According to the combined results with Borda count method, the best and worst performance years for the economic and environmental dimensions are determined as 2018 and 2013, respectively. On the other hand, 2017 is determined as the best performance year for the social dimension with Borda count method, while 2015 is the year of the lowest performance.

Keywords Corporate sustainability · Sustainability performance · Multi-criteria decision making · Hybrid · Case study

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1 Introduction

The concept of sustainability has taken its place in the dictionary in the twentieth century, although it is much older and appears as an environmental perspective in preindustrial societies. According to Lélé (1991), the concept of sustainability emerges in the areas of forests and fisheries due to the use of an extreme amount of wood for shipbuilding, securing mine shafts, and iron smelting operations (Wilderer, 2007), and the need for nutrition for the growing population. However, the main reasons that have led to a serious transformation in nature and human life can be stated as Industrial Revolution, which is a vital step for science and technology and World War II which is the beginning of the unprecedented production and consumption period.

Industrialization, on one hand, is a great way to build economic development and welfare; on the other hand, it is a reason for problems such as increase in pollution, greenhouse gases, global warming, and decrease in biodiversity. Since 1972, starting with United Nations Conference on the Human Environment, many programs and conferences have been organized until today in order to raise awareness and take action on sustainability. As one of them, the 2015 Paris Agreement aims to control the increase in global temperature (United Nations Climate Change UNCC, 2019). However, in the Climate Action Summit 2019, it has been realized that there is still too much to accomplish by nations, and there is an urgent need to take more action. Organizations have a key role to play in achieving sustainable development goals since all make positive and negative contributions toward it (GRI Standards, 2019). The term corporate sustainability can be stated as business-level sustainable development, and it focuses on corporate growth and profitability, while also considers environmental and social goals and development (Yıldızbaşı et al., 2020). Dyllick & Hockerts (2002) defined corporate sustainability as "meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, and communities), without compromising its ability to meet the needs of future stakeholders as well." Bansal (2005) has stated three essential conditions for corporate sustainable development to be realized. Businesses should subordinate the principles of environmental integrity through corporate environmental management, social equality through corporate social responsibility, and economic welfare through value creation to their products, policies, and practices.

Corporations are the major contributors to greenhouse gases and so global emissions (Biró & Csete, 2020). In addition to emissions, environmental problems such as increased pollution and depletion of natural resources have led to a rising demand for organizations to focus on environmental concerns (Garg & Sharma, 2020). Today corporations are more under pressure than before to exhibit how they are contributing to the national sustainability goals (Atkinson et al., 2000). As one of the major concerns of today, corporate sustainability provides companies to fulfill their social responsibility by making production and operation processes more environment-friendly (Yang et al., 2020). The well-being of workers, communities, and the planet is closely related to the sustainability of a company. Companies are crucial instruments to be a solution for the challenges our world's facing such as climate change, water and food crisis, inequality, waste, and pollution (UNGC Guide to Corporate Sustainability, 2020). The goals of the companies regarding corporate sustainability comprise economic, environmental, and social factors which are coined by Elkington (1998) as Triple Bottom Line (TBL). The TBL approach provides an integrated perspective regarding corporations' economic, environmental, and social actions and gets considerably much attention from

policymakers, corporations, and researchers (Martín-Gamboa et al., 2017; Sinha & Anand, 2018).

Corporate sustainability can be seen as internal business betterment strategies (Nicolăescu et al., 2015) and investment to the company itself. Companies that consider corporate sustainability in their internal and external activities minimize their costs, strengthen their financial performance, innovate more, enrich human resources, and increase workforce loyalty (Küçükbay & Sürücü, 2019). Also, it assists to improve the overall performance of the firm by providing easy access to capital, corporate reputation, rising brand value, and attracting qualified workforce.

To be able to demonstrate corporations' actions, precautions, and expectance regarding sustainability, sustainability reporting is a useful tool. It is a great way to inform clearly about negative or positive impacts of companies on the economy, environment, and/or society. Sustainability reporting provides better management of risks related to environmental and social issues and may also be useful in reducing problems that may be encountered by proactive strategies rather than reacting when problems arise. Adopting and reporting sustainable practices helps corporates to increase profitability, integrate risk management, and enable greater stakeholder engagement (Kaur & Sharma, 2018). Furthermore, it is a necessary tool to set goals, evaluate performance, make operations more sustainable. Sustainability reporting also provides a platform to the corporates to meet the changing demands of the stakeholders by offering transparent communication (Singh et al., 2021).

Environmental considerations and socially responsible practices lead to higher sustainable performance for corporations (Zhuang et al., 2019). By reporting, corporations get an opportunity to demonstrate how they satisfy the expectations of costumers and investors regarding sustainable products, sustainable processes, and sustainable manufacturing. Particularly, manufacturing industries attract great attention due to their working conditions, usage of chemicals in production process, generating huge amount of waste, causing more emissions, etc. Sustainability plays crucial role for all processes from raw materials extraction and acquisition to manufacturing, packaging, transportation, using, disposal, reusing, and recycling phases (Anand et al., 2016), and it is crucial to cause minimum waste of materials and energy, minimum energy consumption, and minimum emission of toxic substances to the environment (Anand & Wani, 2010).

Evaluating sustainability performance makes it possible to analyze and to understand the actual performance of firms such as their annual improvement, place in the market, implementations, and activities that they added or removed. Determining the existing level of sustainability is the first step for implementing and improving sustainability practices (Hendiani et al., 2020). In the literature, sustainability performance evaluation is been measured by using balanced scorecard, life cycle assessment, and the most preferably MCDM (Küçükbay & Sürücü, 2019; Wu et al., 2018). MCDM methods are suitable for sustainable performance evaluation since the economic, environmental, and social dimensions of sustainability contain contradictory/complex criteria and decision points and all criteria of these dimensions are crucial. MCDM methods provide objective solutions when the criteria are equally important and cannot be ranked; hence, these methods can be a useful tool for evaluating sustainability performance (Acar et al., 2015). In this study, it is aimed to evaluate the corporate sustainability performance. Different MCDM methods yield diverse outcomes when applied to the same multi-criteria decision problem, and the assortment of an appropriate MCDM method from a long list of MCDM methods is often confusing (Bohlen & Lewis, 2009; Majumder et al., 2020). Each method has pros and cons, and it is very challenging process to decide for the best MCDM method. For a given problem, decision-makers often cannot deduce which MCDM technique is better than the

others. Thus, it is been acknowledged that applying more than one method for a particular problem is more appropriate to get reliable results and safer decision (Mousavi-Nasab & Sotoudeh-Anvari, 2017; Mulliner et al., 2016; Sari, 2020; Wang et al., 2016; Zavadskas et al., 2017; Zinatizadeh et al., 2017). To avoid unclear/skeptical results and make a right final decision, decision-makers tend to apply several MCDM methods to the single problem. Mostly, combining different MCDM methods and constructing a hybrid model are a better way to take the advantage of the strengths of each method (Løken, 2007; Wang et al., 2016; Zavadskas et al., 2017). Additionally, some studies have been proposed that using more than one method provides decision-makers to verify and validate the results (Tavana et al., 2017; Yazdani et al., 2017; Yu et al., 2019; Zhou & Xu, 2018). Based on the literature, three different MCDM methods (VIKOR, TOPSIS, and MAUT) have been applied to evaluate corporate sustainability performance and for determining the weights of criteria, Entropy has been used due to its objectivity. For the last step of the analysis, Borda Count Method which is a data fusion technique has been implemented to be able to get integrated and more rational ranking.

The proposed methodology is performed on a real case, and evaluation of corporate sustainability performance of a manufacturing company which is one of the leading companies in the furniture industry and operating in Turkey is conducted. Our methodology considers the TBL of sustainability and comprehensive criteria of each trivet in order to help to decision-makers on determining the policies that should be taken into consideration when making managerial and strategic decisions within the scope of sustainability activities and provides opportunity to improve the quality of the sustainability reports. The comparative analysis of different methods will aid in establishing the most appropriate and compatible methodology for the purpose of corporate sustainability evaluation. Moreover, since different MCDM methods usually produce different assessment results (ranks) and for this reason using only one ranking algorithm may not be robust, three MCDM algorithms are provided and the final ranking is aggregated with the Borda count method. The Borda count is used as a tool for the ranking of alternatives based on all MCDM assessments (Zavadskas et al., 2017).

Although the literature contains much useful research regarding sustainability, there is still a great need for contribution in this field since most of the studies are interested in sustainable supplier selection. Measuring and evaluating their own sustainable performances is very important for companies to be able to aware of what are the contributions/effects of them to the sustainable development. Compared to the large amount of economic performance evaluation studies in the literature, environmental and especially social performance measurements are insufficient. When we examine the studies on sustainability performance measurement in the literature, we have not encountered any study that measures corporate sustainability performance in the furniture industry which has great importance on sustainability because of deforestation. Furthermore, to the best knowledge of the authors, it is the first study that measures the corporate sustainability performance via VIKOR method. The contributions of this paper can be stated as follows: (i) implementing VIKOR method for the corporate sustainability performance evaluation, (ii) showing a methodology that hybridizing the entropy method for criteria weightings with three MCDM methods (VIKOR, TOPSIS, and MAUT) for sustainability performance measurement on a case study, (iii) validating the results via comparative analysis, (iv) presenting a robust ranking via the Borda count method for aggregating MCDM algorithms, (v) guiding decision-makers in evaluating the sustainability performance of corporates over the years, (vi) helping to determine which policies should be taken into consideration when making managerial and strategic decisions within the scope of sustainability activities, and (vii) providing

opportunity to improve the quality of the sustainability reports and sustainability processes of the firms.

The rest of the paper is organized as follows: Sect. 2 presents a brief review of the literature on performance measurement of corporate sustainability. In Sect. 3, the proposed methodology is described. In Sect. 4, the proposed methodology is performed on a real case and results and discussions are given. Main conclusions and future research are offered in Sect. 5.

2 Literature survey

Increasing environmental and social awareness makes businesses aware that the importance of their corporate reputation is just as vital as their economic profitability. Current sustainability activities, sustainability understandings, goals, and performances of firms assist them to construct their corporate reputation to compete in the market and sustain their existence. By assessing and monitoring sustainability performances, firms are able to make strategic sustainable decisions (Wicher et al., 2019) and attract their investors and consumers. To assess and evaluate firms' sustainability performance and assist decision-makers with their strategic decisions, some studies are conducted in the literature. Since MCDM can be an appropriate tool when there are several conflicting criteria to consider for the best decision, it is used for measuring sustainability performance in several studies. The studies that perform the corporate sustainability performance measurement found in the literature with MCDM methods are mentioned in Table 1. The sustainability dimensions that studies take into account, the used MCDM methods for performance measurement and the sectors they deal with are given in the table.

Measuring corporate sustainability performance is one of the significant topics that enable to investigate sustainability activities of corporations annually or to compare the sustainability performance of firms activating in a specific sector at a certain time. Eş (2008), Öztel et al. (2012), Alp et al. (2015), Gürül (2016), Ersoy (2018), Öztel et al. (2018), and Şeker (2018) have measured the performance of a selected firm over the years, while Diaz-Balteiro et al. (2011), Shanmugam et al. (2015), Medel-González et al. (2016), Raut et al. (2017), and Lamata et al. (2018) have taken into account more than one firms competing in the same sector or from different sectors to compare their sustainability performances. There are many MCDM methods available in the literature, which can be categorized based on different purposes, with some pros and cons for each method (Khedrigharibvand et al., 2019). Mostly, TOPSIS method has been used for ranking and entropy method has been used for weighting due to their convenience and objectivity. In the perspective of sectors, the banking and energy are the most popular sectors regarded in the sustainability performance measurement literature.

3 Research method

MCDM methods have been used in various theoretical and practical fields for a long time (Nayak & Tripathy, 2019), especially in performance measurements such as finance, production, transportation, system, supply chain, management, etc. There are various methods to determine criteria weighting and alternatives ranking. In this study, entropy method that is one of the most preferred objective weighting methods has been proposed to avoid

Table 1 Literature Survey of Corporate Sustainability Performance Evaluation

Author	Study year	Sustainability dimensions	Method	Company/Sector
Erol and Özmen	2008	Environmental	AHP and TOPSIS	Three retail companies
Eş	2008	Three dimensions	Entropy, ELECTRE and TOPSIS	British Petroleum
Özer	2010	Three dimensions	Entropy and TOPSIS	98 companies in GRI List in 2009
Diaz-Balteiro et al.	2011	Three dimensions	CP	European paper industry (17 European countries)
Govindan et al.	2012	Three dimensions	Fuzzy TOPSIS	Supplier selection
Lee and Saen	2012	Three dimensions	Advanced DEA	Ten companies operating in the electronics industry in Korea
Öztel et al.	2012	Environmental and social	Entropy and CP	Henkel
Yeh and Xu	2012	Three dimensions	Optimal weighting model and fuzzy TOPSIS	E-recycling company
Kannan et al.	2013	Economic and environmental	Fuzzy AHP, fuzzy TOPSIS, fuzzy MOLP	Green supplier selection
Shen et al	2013	Environmental	Fuzzy TOPSIS	Green supplier's performance
Tsai et al.	2013	Environmental	DEMATEL, ANP, Zero–One Goal Programming	Green building projects
Govindan et al.	2014	CSR	Fuzzy DEMATEL	Mining Industry
Özçelik and Öztürk	2014	Three dimensions	GRA	Three banks operating in Turkey
Acar et al.	2015	Environmental	TOPSIS	A company in the textile industry
Alp et al.	2015	Three dimensions	Entropy and MAUT	Linde
Carnero	2015	Environmental	Fuzzy AHP and Utility Theory	Two health institutions
Shanmugam et al.	2015	CSR	Structural Equation Model and AHP	India manufacturing industry (50 companies from five different sectors)
Sürücü	2015	Three dimensions	AHP and TOPSIS	Five international logistics companies
Tanç and Gümrah	2015	Environmental	TOPSIS	Nine companies in manufacturing industry listed on BIST
Wang et al.	2015	CSR	Entropy and GRA	Eight major airlines in China
Afful-Dadzie et al.	2016	Three dimensions	TOPSIS	Seven European banks

Table 1 (continued)

Author	Study year	Sustainability dimensions	Method	Company/Sector
Aras et al.	2016	Three dimensions + governance and finance	Entropy and TOPSIS	Comparing conventional banks with participation banks
Erguden and Catlioglu	2016	CSR	TOPSIS	Four companies in the energy industry listed on BIST
Medel-González et al.	2016	Three dimensions	SBSC, ANP and Matrix of Sustainable Strategic Alignment	Four power plants operating in Cuba
Gürül	2016	Three dimensions	Entropy and TOPSIS	A company in the leather industry in Turkey
Bulut	2017	Three dimensions	AHP	Four banks operating in Turkey
Ömürbek et al.	2017	Financial, operational, and environmental	Entropy, ARAS, MOOSRA and COPRAS	Seven banks operating in Turkey
Raut et al.	2017	FS, CRM, IBP, EFMS	BSC, Fuzzy AHP and Fuzzy TOPSIS	Six major banks of India
Ersoy	2018	Three dimensions	Entropy, TOPSIS and GRA	Arçelik
Aras et al.	2018	Three dimensions + finance and governance	Content Analysis, Entropy, TOPSIS	Four banks operating in Turkey
Lamata et al.	2018	CSR	Fuzzy AHP and TOPSIS	Ten companies operating in different industries
Öztel et al	2018	Three dimensions	Entropy and TOPSIS	Akenerji
Sofyalıoğlu and Sürücü	2018	Three dimensions	AHP and TOPSIS	A white goods company in Turkey
Şeker	2018	Three dimensions	Entropy and PROMETHEE	Tüpraş
Küçükbay and Sürücü	2019	Three dimensions	Multimoora	25 companies listed in Fortune 500, USA
Wicher et al.	2019	Three dimensions	Fuzzy ANP	15 companies in metallurgical industry
Proposed Study	2019	Three dimensions	Entropy, TOPSIS, VIKOR, and MAUT	Bellona/Furniture

AHP Analytic Hierarchy Process, *ANP* Analytic Network Process, *ARAS* Additive Ratio Assessment, *BIST* Borsa İstanbul, *BSC* Balanced Scorecard, *COPRAS* Complex Proportional Assessment, *CP* Compromise Programming, *CSR* Corporate Social Responsibility, *ELECTRE* Elimination and Choice Translating Reality English, *FS* Financial Stability, *GRA* Grey Relational Analysis, *MAUT* Multi-Attribute Utility Theory, *MOLP* Multi-Objective Linear Programming, *PROMETHEE* The Preference Ranking Organization Method for Enrichment Evaluation, *SBSC* Sustainability Balanced Scorecard, *TOPSIS* Technique for Order Preference by Similarity to Ideal Solution, *VIKOR* VIseKriterijumska Optimizacija I Kompromisno Resenje

subjective judgment of decision-makers. For ranking the alternatives, three methods have been implemented with the aim of obtaining reliable results. We have used VIKOR, TOPSIS, and MAUT methods, which are among the most preferred methods in MCDM. VIKOR and TOPSIS methods are chosen because of being effective and easily practicable measures for ranking and monitoring the sustainability performance as proposed in the recent literature (Piwowarski et al., 2018; Roszkowska & Filipowicz-Chomko, 2016, 2020; Ture et al., 2019; Zinatizadeh et al. 2017). The four main advantages of TOPSIS are given in the study of Shih et al. (2007) as "(i) a sound logic that represents the rationale of human choice; (ii) a scalar value that accounts for both the best and worst alternatives simultaneously; (iii) a simple computation process that can be easily programmed into a spreadsheet; and (iv) the performance measures of all alternatives on attributes can be visualized on a polyhedron, at least for any two dimensions." Authors also pointed out that: "these advantages make TOPSIS a major MCDM technique as compared with other related techniques." Besides the given advantages of TOPSIS, the VIKOR method also has a great advantage to handle MCDM problems with non-commensurable and even conflicting criteria, and to obtain the compromised optimal solution (Fei et al., 2019). The superior aspects of TOPSIS and VIKOR methods are to allow the use of variables with different units of measure and criteria of different types (Caterino et al., 2009). Although they approach the decision problem in a similar manner, they use different normalization (vector normalization in TOPSIS and linear normalization in VIKOR) techniques for the variables in the decision matrix and different aggregation techniques. The VIKOR method of compromise ranking determines a compromise solution, providing a maximum "group utility" for the "majority" and a minimum of an individual regret for the "opponent'." The TOPSIS method determines a solution with the shortest distance to the ideal solution and the greatest distance from the negative ideal solution, but it does not consider the relative importance of these distances (Opricovic & Tzeng, 2004). On the other hand, MAUT is one of the most famous tools of the MCDM method (Bhole & Deshmukh, 2018). The featured advantages of MAUT are that it takes uncertainty into account (Bhole & Deshmukh, 2018; Velasquez & Hester, 2013), it is simple to understand and allows easy calculation, and it has good software support (Cinelli et al., 2014).

3.1 Data

The furniture sector has an important role in sustainability due to the overmuch waste that the sector caused and the consumption of national sources. In this section, sustainability performance of a company operating in furniture industry in Turkey has been measured. Although the company publishes the Corporate Social Responsibility (CSR) report in line with the United Nations Global Compact (UNGC), since more detailed data are needed for measurement, sustainability criteria in the study have been gathered not only based on UNGC but also based on comprehensive literature survey and Global Reporting Initiative (GRI). Based on the TBL approach, we consider three dimensions of the sustainability which are economic, environmental, and social. Economic dimension concerns corporations' impact on the economic conditions of its stakeholders and on economic systems at local, national, and global levels. Environmental dimension encompasses corporations' impact on living and non-living natural systems such as land, air, water and ecosystems. This category is related to energy, water, emissions, waste, biodiversity, transport, and environmental expenditures. Social dimension covers the topics related to labor practices and decent work, human rights, society, and product responsibility.

In line with the firm's choice and approval and availability of data, 33 criteria have been considered in the study. For economic category, seven criteria have been determined as revenue, operating profit, equity, export earnings, R&D expenditure, gross value added, and total assets as in (Alp et al., 2015; Aydın, 2020; Diaz-Balteiro et al., 2011; Ersoy, 2018; GRIG4, 2020). Eleven components that are electricity, natural gas, solid fuel consumptions, wastewater, CO2 emissions, amount of solid waste, disposed solid waste, recycled solid waste, recovered solid waste, recycled product ratio, and total shipping distance have been chosen for environmental dimension as in (Acar et al., 2015; Afful-Dadzie et al., 2016; Alp et al., 2015; Carnero, 2015; Erol & Özmen, 2008; Ersoy, 2018; Özçelik and Öztürk, 2014; Öztel et al., 2012; Medel-González et al., 2016). Lastly, 15 criteria (personnel job satisfaction rate, total number of personnel, average personnel age, average personnel actual service period, turnover rate, disabled personnel ratio, intern personnel ratio, female personnel ratio, ratio of female personnel in management positions, number of registered work accidents, lost workday as a result of work-related injury and disease, ratio of personnel with training opportunities, training day per personnel, training program expenditure per personnel, personnel training on green environment, and green production) have been determined for social dimension as in (Afful-Dadzie et al., 2016; Alp et al., 2015; Gürül, 2016; Lee & Saen, 2012; Ömürbek et al., 2017; Özçelik & Öztürk, 2014; Öztel et al., 2018; Medel-González et al., 2016; Sofyalıoğlu & Sürücü, 2018). The criteria used in the analysis of the sustainability performance of the firm are given in Table 2. Since the analysis has been performed separately for three dimensions, codes have been specified for the criteria of dimensions (E-code for economic criteria, C-code for environmental criteria, and S-code for social criteria).

For economic perspective, all criteria have been taken as benefit-based because the increase in the value of the criteria included in the analysis is beneficial for the firm. For environmental perspective; the increase in energy consumption, fuel, and waste has been taken as cost-based criteria as it has a negative impact on the sustainability of the firm. In line with the information obtained from the firm, the use of materials such as packaging, protective paper, styrofoam, etc. is reduced through investments and continuous improvement studies. R&D expenditure focuses on improving the environmental effect of the firm by reducing generation of waste. The firm has adopted the strategy of production with the lowest consumption and reducing the waste amounts. So, criteria related to produced waste amounts have been considered as cost-based, while recycling ratio criterion has been taken as benefit-based. For the environmental dimension, the main objective is to reduce all types of waste while increasing the recycling rate. Employee qualification and awareness are significant for the social sustainability. Therefore, criteria including investments made on employees have been considered benefit-based, while criteria about accidents, injuries, and turnover rate have been considered as cost-based. The six years (2013–2018) that we have handled as alternatives for comparing the sustainability performance of the firm are represented by the codes specified in Table 3.

3.2 Entropy Method

The entropy method, introduced by Shannon in 1948, has been developed as "A statistical parameter which measures, in a certain sense, how much information is produced on the average for each letter of a text in the language" (Shannon, 1951). With the development of the mathematical structure of information theory, Shannon has aimed to reduce the loss of information that would occur during the reproduction of a selected message

Table 2 Sustainability Criteria

	Criteria	Code
Economic criteria	Revenue (TL)	E1
	Operating Profit (TL)	E2
	Equity (TL)	E3
	Export Earnings (TL)	E4
	R&D Expenditure (TL)	E5
	Gross Value Added (TL)	E6
	Total Assets (TL)	E7
Environmental criteria	Electricity Consumption (kWh)	C1
	Natural Gas Consumption (kWh)	C2
	Solid Fuel Consumption (ton)	C3
	Wastewater (m3)	C4
	Carbon Dioxide Emissions (ton)	C5
	Amount of Solid Waste (ton)	C6
	Amount of Disposed Solid Waste (ton)	C7
	Amount of Recycled Waste (ton)	C8
	Amount of Recovered Waste (ton)	C9
	Recycled Product Ratio	C10
	Total Shipping Distance (km)	C11
Social criteria	Personnel Job Satisfaction Rate	S1
	Total Number of Personnel	S2
	Average Personnel Age	S3
	Average Personnel Actual Service Period	S4
	Personnel Turnover Rate	S5
	Disabled Personnel Ratio	S6
	Intern Personnel Ratio	S7
	Female Personnel Ratio	S8
	Ratio of Female Personnel in Management Positions	S9
	Number of Registered Work Accidents	S10
	Lost Workday as a Result of Work-related Injury and Disease	S11
	Ratio of Personnel with Training Opportunities	S12
	Training Day Per Personnel	S13
	Training Program Expenditure Per Personnel	S14
	Personnel Training on Green Environment and Green Production	S15

TL Turkish Lira, *kWh* KiloWatt Hour, *km* Kilometer, *R&D* Research and Development

Table 3 Alternatives

Alternatives	Codes
2013	A1
2014	A2
2015	A3
2016	A4
2017	A5
2018	A6

at another point (Bostancı & Ocakçı, 2009). In MCDM problems, the valuation of criteria creates different ideas and meanings. The necessity to specify each attribute with a weight of special importance raises the question of how to calculate these significance weights. The answer of this question has been divided into two groups as subjective and objective methods. Among the objective weighting methods developed for cases where reliable subjective weights cannot be determined, the entropy method which is effective in measuring uncertainty has an important place (Shemshadi et al., 2011). With no significant modeling difficulties, it eliminates human-made disturbances effectively and makes decision making more reliable (Dehdasht et al., 2020; Fei et al., 2019). The steps of the method can be listed as determining the normalized decision matrix—Eq. (1), calculating the entropy value—Eq. (2), defining the divergence—Eq. (3), and calculating the weights—Eq. (4) (Ersoy, 2018; Öztel et al., 2018; Rudnik, 2017; Shemshadi et al., 2011):

$$r_{ij} = x_{ij} / \sum_{i=1}^{m} x_{ij} \tag{1}$$

$$e_j = -k \sum_{i=1}^{m} r_{ij} \ln r_{ij} \; and \; k = \frac{1}{\ln m} \tag{2}$$

$$d_j = 1 - e_j \tag{3}$$

$$w_j = d_j / \sum_{j=1}^{n} d_j, \; \sum_{j}^{n} w_j = 1 \tag{4}$$

3.3 VIKOR Method

VIKOR (VIseKriterijumska Optimizacija I Kompromisno Resenje), which was presented as a compromise solution method, was developed by Opricovic in 1998 as a MCDM method (Opricovic & Tzeng, 2004). The method specifies a compromise solution that provides maximum group benefit for the majority and minimum individual regret for the competitor (Chen & Wang, 2009). As a basic concept, VIKOR defines positive and negative ideal points. It focuses on selecting and ranking from a limited number of viable alternatives in the presence of criteria that are conflicting and can be measured in different units. VIKOR is a powerful method that can solve following problems effectively when "(1) decision-makers cannot determine how to express their preferences accurately, (2) there are conflicts and incommensurability between evaluation criteria (different measure units), (3) decision-makers that deal with the conflict can accept the compromise solution." (Fei et al., 2019). The ranking is based on closeness to the ideal solution in the method (Chatterjee & Chakraborty, 2016). VIKOR method starts with the form of L_{p-} metric which is calculated as in Eq. (5) (Chatterjee & Chakraborty, 2016; Gök-Kısa & Perçin, 2018; Lin et al., 2021; Nayak & Tripathy, 2018; Nayak et al., 2019; Opricovic & Tzeng, 2004, 2007; Sayadi et al., 2009; Suárez Silgado et al., 2018)

$$L_{pi} = \left\{ \sum_{j=1}^{n} \left[\left(f_j^* - f_{ij} \right) / \left(f_j^* - f_j^- \right) \right]^p \right\}^{1/p} \quad 1 \le p \le \infty; j = 1, 2, \ldots, m \tag{5}$$

f_{ij} represents the value of criteria j for the alternative i.

m represents the number of the alternatives.

Steps of the VIKOR method can be listed as determining the best (f_j^*) and the worst (f_j^-) values of all criteria—Eqs.(6)–(7), calculating S_i and R_i values—Eqs. (8)–(9), computing the Q_i value—Eq. (10), sorting the values of S, R, and Q in decreasing order, and proposing alternative $A^{'}$ that ranked the best measure by Q_{min} as a compromise solution if two conditions are satisfied which are defined as in C1 and C2. To resolve the conflicts among the criteria, VIKOR uses majority and opponent rules. $L_{1,i}$ (represented as S_i in Eq. 8) and $L_{\infty,i}$ (represented as R_i in Eq. 9) are used to formulate ranking measure, where $\min_i S_i$ computes the maximum group utility (majority rule) and $\min_i R_i$ computes individual regret of the opponent:

$$f_j^* = \max_j f_{ij},\ f_j^- = \min_j f_{ij},\ \text{if the criteria} i \text{ represents a benefit} \tag{6}$$

$$f_j^* = \min_j f_{ij},\ f_j^- = \max_j f_{ij},\ \text{if the criteria} i \text{ represents a cost} \tag{7}$$

$$S_i = \sum_{j=1}^{n} w_j \left(f_j^* - f_{ij} \right) / \left(f_j^* - f_j^- \right) \quad (i = 1, 2, \ldots, m) \tag{8}$$

$$R_i = \max\ w_j \left(f_j^* - f_{ij} \right) / \left(f_j^* - f_j^- \right) \quad (i = 1, 2, \ldots, m) \tag{9}$$

$$Q_i = v(S_i - S^*)/(S^- - S^*) + (1 - v)(R_i - R^*)/(R^- - R^*)\ (i = 1, 2, .., m) \tag{10}$$

v is the weight of majority of criteria (in this work it is assumed $v = 0,5$.)

$1 - v$ is weight of the individual regret.

Ranking the alternatives in accordance with decreasing order value of S, R, and Q, the minimum Q value is the best alternative. Q_{min} value conditions are:

C1. Acceptable advantage: $Q\left(A^{(2)}\right) - Q\left(A^{(1)}\right) \ge DQ$.

$A^{(2)}$: The alternative with second position in the ranking list,

$DQ = 1/(m-1)$; m is the number of alternatives.

C2. Acceptable stability in decision making: The alternative $A^{(1)}$ must also be the best ranked alternative list S or/and R. That means the compromise solution is stable and satisfies majority rule ($v > 0,5$) or consensus ($v = 0,5$) or with veto ($v < 0,5$).

If one of the conditions is not satisfied, then a set of compromise solutions is proposed as follows:

- If the condition C2 is not satisfied, alternatives $A^{(1)}$ and $A^{(2)}$.
- If the condition C1 is not satisfied, alternatives $A^{(1)}$, $A^{(2)}$, …, $A^{(m)}$ are determined with $Q\left(A^{(m)}\right) - Q\left(A^{1}\right) < DQ$

3.4 TOPSIS method

Method presented by Hwang and Yoon in 1981 determines the alternative that is closest to the ideal solution and the farthest from the negative ideal solution as the best alternative (Ocampo, 2019; Opricovic & Tzeng, 2004; Tzeng & Huang, 2011). Since the method adopts the principle of closeness to the ideal solution, it does not optimize the solution but provides a ranking of preference for the problem (Acar et al., 2015). The solution of the method not only maximizes the benefit criteria but also minimizes the cost criteria (Dehdasht et al., 2020). It deals with subjectivity in a very limited way (Erguden & Catlioglu, 2016); thus, it is particularly suitable for cases where objective or quantitative data are provided. The main advantage of TOPSIS is simplicity and it requires the same number of processes regardless of alternative and criteria numbers (Sari, 2020). It is a widely accepted MCDM method due to easily programmable computation procedure (Kaya & Kahraman, 2011). The steps of the method can be listed as determining the normalized decision matrix—Eq. (11), calculating the weighted normalized decision matrix—Eq. (12), determining the negative and positive ideal solutions—Eqs. (13)–(14), calculating the distance from positive (D_i^+) and negative (D_i^-) ideal solutions—Eqs. (15)–(16), and calculating the relative closeness to the positive ideal solution—Eq. (17) (Coban et al., 2018; Mao et al., 2016; Opricovic & Tzeng, 2004; Roszkowska, 2011):

$$r_{ij} = a_{ij} / \sqrt{\sum_{i=1}^{m} a_{ij}^2} \tag{11}$$

$$v_{ij} = w_j * r_{ij} \tag{12}$$

$$\begin{aligned} A^+ &= \left(v_1^+, v_2^+, v_3^+, \ldots, v_n^+\right) \\ A^+ &= \left\{\left(max_j v_{ij} | j \in J\right), \left(min_j v_{ij} | j \in J'\right)\right\} \end{aligned} \tag{13}$$

$$\begin{aligned} A^- &= \left(v_1^-, v_2^-, v_3^-, \ldots, v_n^-\right) \\ A^- &= \left\{\left(min_j v_{ij} | j \in J\right), \left(max_j v_{ij} | j \in J'\right)\right\} \end{aligned} \tag{14}$$

J represents benefit criteria, while J' represents cost criteria.

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_i^+\right)^2} \tag{15}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_i^-\right)^2} \tag{16}$$

$$C_i^* = D_i^- / \left(D_i^+ + D_i^-\right), \; 0 \le C_i^* \le 1 \tag{17}$$

3.5 MAUT Method

The utility theory which was introduced by Fishburn (1967) and Keeney (1974) and improved by Løken (2007) (Ömürbek et al., 2016) mediates the choice between conflicting targets, and it is a useful practice for many fields (economics, behavioral research and industrial engineering, etc.) (Hu, 2019). In contrast to many MCDMs, the main advantage of MAUT method is that it takes uncertainty into account. It can be said that every step of the method is comprehensive as it can include the preferences of each result (Velasquez & Hester, 2013). The basic hypothesis is based on the real-valued function U defined on a set of viable alternatives that the decision-maker wants to maximize (Olson, 1996). It is the most famous tool of the MCDM methods. There are some important advantages that make MAUT popular such as easy calculation, straightforward mechanism (Bhole & Deshmukh, 2018), good software support (Cinelli et al., 2014). Method takes place prominently in several combined methods (Velasquez & Hester, 2013). MAUT method's first step calculates the normalized utility value—Eq. (18), the second step derives the multi-attribute utility functions—Eq. (19), and in the last step the alternatives are ranked in accordance with the increasing order (Ananda & Herath, 2005; Kim & Song, 2009; Ömürbek et al., 2016; Zietsman et al., 2006).

MAUT can change the multiple interests into numerical values on a scale of 0–1 with 0 representing the worst and 1 representing the best choice. This allows direct comparison of various sizes (Ramadiani et al., 2018) and using both quantitative and qualitative criteria. After valuing 0 for the minimum and 1 for the maximum criteria, the equation below will be used to determine for others:

$$u_i(x_i) = \left(x - x_i^-\right) / \left(x_i^+ - x_i^-\right) \tag{18}$$

x_i^+ is maximum criteria value, x_i^- minimum criteria value, x: The criteria value in the calculated row

$$U_{(x)} = \sum_{1}^{m} u_i(x_i) w_j,\ U_{(x)} \text{ is the value of the alternative} \tag{19}$$

3.6 Borda Count Method

Borda Count method is one of the voting methods in social choice theory. The method was developed by Jean-Charles de Borda (1784). Borda count method is based on group decision theory that integrates a set of individual rankings. Borda count is referred to as useful group consensus function. If we presume n is the number of alternatives, the most preferred alternative will be given n-1 score while the least preferred alternative will be zero (Nuray & Can, 2006). "The consensus ranking is given by arranging the classes so that their Borda counts are in descending order." (Ho et al., 1994). These scores state Borda ranking.

4 Results and discussions

In this section, firstly the outcomes of the entropy method and then the results of VIKOR, TOPSIS, and MAUT methods are given, respectively. For all methods, results of analyses that belong to economic, environmental, and social dimensions of sustainability have been

Table 4 Weights for criteria

	E1	E2	E3	E4
w_j	0,063815935	0,150514485	0,071688486	0,024199256
	E5	E6	E7	
w_j	0,48089075	0,113291783	0,095599305	
	C1	C2	C3	C4
w_j	0,007321167	0,020879491	0,141020853	0,040028812
	C5	C6	C7	C8
w_j	0,123174784	0,116894776	0,046413468	0,152877362
	C9	C10	C11	
w_j	0,292904418	0,050376774	0,008108095	
	S1	S2	S3	S4
w_j	0,009423223	0,001615726	0,002780536	0,022838585
	S5	S6	S7	S8
w_j	0,284482069	0,01974208	0,119458116	0,003968545
	S9	S10	S11	S12
w_j	0,047906316	0,041957021	0,226873193	0,0001625
	S13	S14	S15	
w_j	0,010569698	0,188460413	0,019761979	

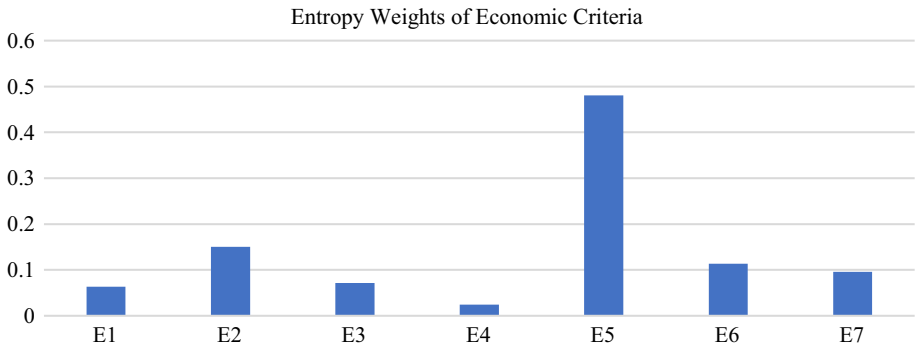


Fig. 1 Entropy weights of economic criteria

ranked separately and then compared with each other. Lastly, the results of Borda count method have been presented.

The weights of economic, environmental, and social criteria are obtained by using the formulas listed in the previous section and presented in Table 4 (also visualized in Figs. 1, 2 and 3). According to the results of the analysis, the E5 (R&D Expenditure) criterion appears to be of high importance. The criterion is followed by E2 (Operating Profit) and E6 (Gross Value Added), respectively. Among the environmental criteria, the most important criterion appears to be C9 (Amount of Recovered Waste), followed by C8 (Amount of Recycled Waste) and then C3 (Solid Fuel Consumption), respectively. Lastly, social criteria entropy results show that S5 (Personnel Turnover Rate) is the most important criterion, followed by S11 (Lost Workday as a Result of Work-related Injury and Disease) and then S14 (Training Program Expenditure Per Personnel).

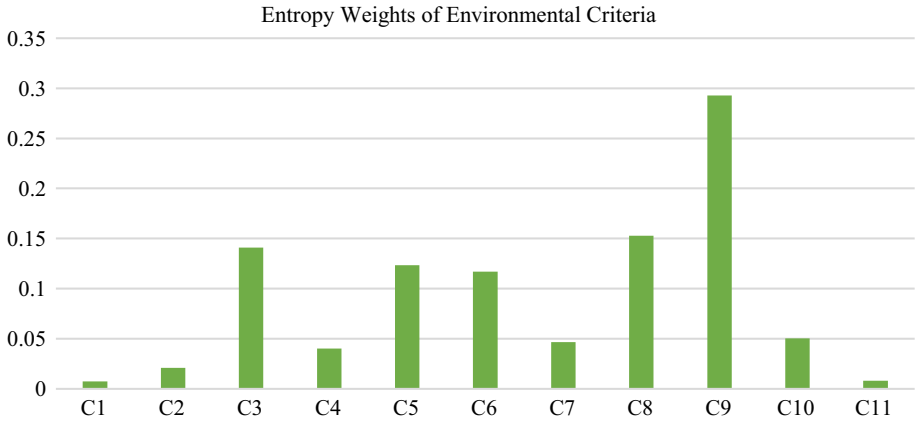


Fig. 2 Entropy weights of environmental criteria

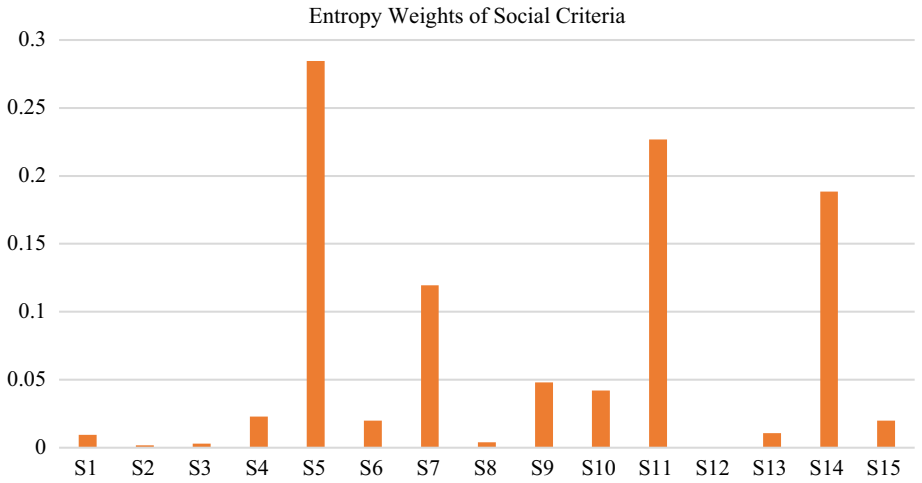


Fig. 3 Entropy weights of social criteria

The results of VIKOR method are given in Table 5. In this method, as mentioned in the methodology section (VIKOR step 4), ranking is acceptable only if C1 and C2 conditions are satisfied. According to the results, while these two conditions have been satisfied in economic analysis, only C2 condition has been satisfied in environmental and social dimensions. Since C1 condition has not been satisfied, $Q\left(A^{(m)}\right) - Q\left(A^{1}\right) < DQ$ formulation is calculated as a compromise solution.

Results of compromise solution presented in Table 6 show that 2018 is the best year for environmental analysis in the ranking list, while 2017 is the best for the social analysis.

In terms of the economic analysis of VIKOR, results completely have an increasing tendency while environmental and social analyses results are fluctuating. Even though the ranking lists are all different from each other according to the results, the best performance

Table 5 Q values

Alternatives	Economic	Environmental	Social
A1	1	1	0,577168943
A2	0,923973396	0,343852168	0,688303546
A3	0,820820087	0,346728855	0,998872791
A4	0,333791959	0,14459464	0,437836939
A5	0,239242285	0,270302534	0,116376252
A6	0	0	0,202689286

and the worst performance years are 2018 and 2013, respectively for both economic and environmental analysis.

The results of the TOPSIS method are given in Table 7. The economic results show that there has been a quite increase from 2013 to 2018. The economic performance of the firm follows an increasing trend, except for a slight decline in 2017. Since the criterion of R&D expenditures has very high weight value, almost 50%, it has affected the performance ranking mostly. According to the environmental analysis of TOPSIS, the years of 2014, 2017, and 2018 have almost the same results. While the year of 2013 has the lowest, 2016 has the highest performance. In addition, environmental performance has been fluctuating over the years and has similar tendency except for the year of 2013. In the social analysis perspective, while the year of 2018 has the highest performance, the lowest performance belongs to the year 2015. It is also noteworthy in the analysis that there is a decreasing tendency between the years 2013 and 2015, whereas there is an increasing tendency between the years 2016 and 2018.

The results of the MAUT method are given in Table 8. When results are analyzed, it can be said that ranking lists are almost the same with the other analyses since the results of the economic analysis have an increasing trend and the other two analyses' results are fluctuating (Table 8). The best and worst performance years are determined as 2018 and 2013 in

Table 6 Compromise solution for VIKOR ranking

Environmental		Social	
Q(Am)-Q(A1)	< DQ	Q(Am)-Q(A1)	< DQ
0,14459464	< DQ	0,086313034	< DQ
0,270302534	> DQ	0,321460687	> DQ
0,343852168	> DQ	0,460792692	> DQ
0,346728855	> DQ	0,571927295	> DQ
1	> DQ	0,882496539	> DQ

Table 7 C_j^* values

Alternatives	Economic	Environmental	Social
A1	0,031422238	0,219468344	0,562449208
A2	0,085084716	0,685439127	0,524027418
A3	0,164149066	0,549627479	0,350829946
A4	0,75297761	0,767488511	0,573032909
A5	0,684374841	0,680550829	0,666976068
A6	0,931122053	0,686794099	0,718751113

Table 8 $U_{(x)}$ values

Alternatives	Economic	Environmental	Social
A1	0,045740631	0,191845513	0,546194272
A2	0,097558311	0,50374152	0,464115019
A3	0,207982039	0,463410238	0,464816471
A4	0,536512872	0,689218127	0,705324866
A5	0,727183717	0,596168315	0,77526035
A6	0,942615613	0,761559735	0,6491287

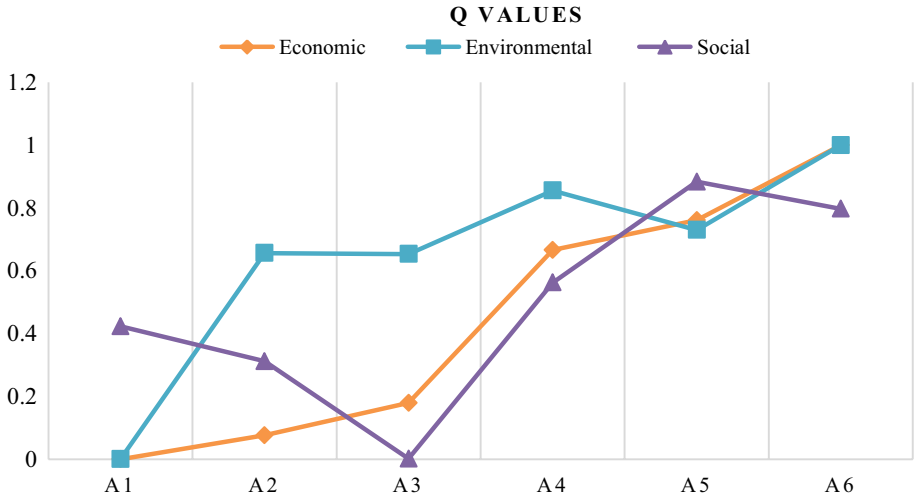


Fig. 4 Results of VIKOR method (subtracted from 1)

terms of economic and environmental analysis, in line with the VIKOR results. In terms of the social performance of the firm, the year 2017 is the best, and 2014 is the worst.

According to all three methods, it can be resulted that there is a general improvement over the years in the sustainability performance of the firm (Figs. 4, 5, and 6). There is an overall increase in the economic performance of the firm. Although there is also an upward trend for both environmental and social performances, these performances are fluctuating over the years.

The alternative which has the smallest value in the VIKOR method is considered to be the most satisfactory result; hence, we have subtracted results of VIKOR from 1 to avoid the confusion. Figures show that the environmental and social performances of the firm are not steady. It can be concluded from these results that although the firm seems willing to improve its performance, it is still experiencing instability in environmental and social investments. Results of the three methods are shown all together in Table 9.

When results are compared, it can be said that VIKOR and MAUT ranking lists are the same for economic and environmental dimensions and almost the same for social. In terms of the results of economic dimension in TOPSIS, while the second-best performance is actualized in the year of 2016, results of VIKOR and MAUT analyses tend to increase over the years. The reason TOPSIS has different results for the economic dimension is that

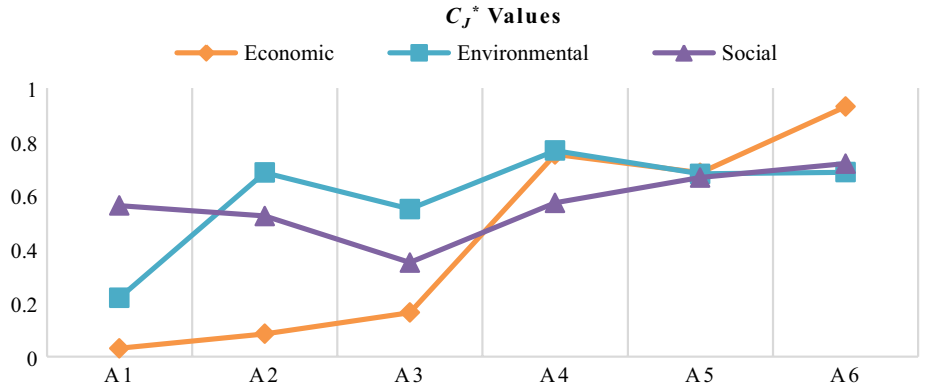


Fig. 5 Results of TOPSIS method

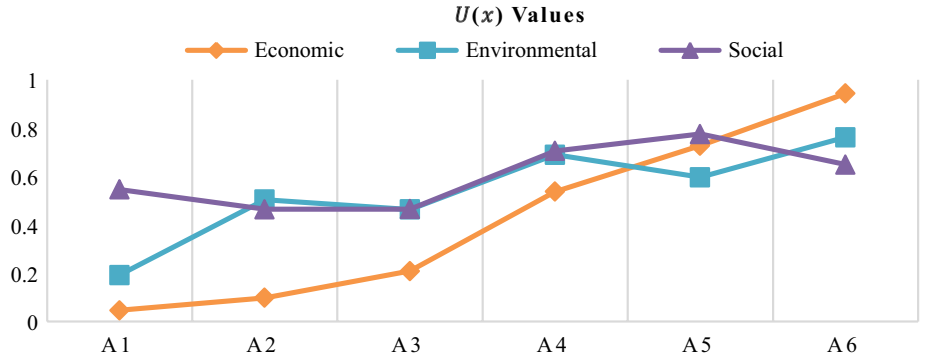


Fig. 6 Results of MAUT method

Table 9 Comparison of ranking list

Ranking	Economic results			Environmental results			Social results		
	VIKOR	TOPSIS	MAUT	VIKOR	TOPSIS	MAUT	VIKOR	TOPSIS	MAUT
1	2018	2018	2018	2018	2016	2018	2017	2018	2017
2	2017	2016	2017	2016	2018	2016	2018	2017	2016
3	2016	2017	2016	2017	2014	2017	2016	2016	2018
4	2015	2015	2015	2014	2017	2014	2013	2013	2013
5	2014	2014	2014	2015	2015	2015	2014	2014	2015
6	2013	2013	2013	2013	2013	2013	2015	2015	2014

there is a decrease in the main data for the R&D Expenditure criterion. Since TOPSIS has not ignored the decrease in the main data, ranking list has been affected from this situation. According to all three methods, results of environmental and social dimensions are fluctuating. While the best performance year for social dimension for VIKOR and MAUT

methods is 2017, for TOPSIS the best social performance is shown in the year 2018. On the other hand, while best performance in terms of environment is shown in 2016 according to TOPSIS method, it is shown in 2018 according to both of VIKOR and MAUT. As a result, there is no striking difference between the three used methods for sustainability performance evaluation and it can be said that the year 2018 is the most successful regarding sustainability as a whole. Figures 7, 8, and 9 visualize the results of specific dimensions for all three methods.

Evaluating the results of the methods on a specific dimension shows that when there is an increase or a decrease, all methods point in the same direction. On the other hand, it is noteworthy that VIKOR is more sensitive than others since fluctuations are more explicit. On contrary, the results of the TOPSIS method fluctuate less. This difference may be due to the methods having different normalization processes. On the last step of the analysis, the Borda count algorithm has been implemented in order to obtain an integrated ranking list. In the ranking, the least preferred alternative has got zero, while the most preferred has five. The ranking list has been provided for three pillars of sustainability. Table 10 shows the Borda ranking list.

Table 10 shows that the firm is not stable on environmental and social dimensions unlike economic dimension. Still in general, it can be concluded that the sustainability performance of the firm is improving over the years. Borda count method shows that for the environmental dimension the best performance year is 2018 which is the last year of the analysis. 2016 which is the second-best year is followed by 2017 in terms of environmental sustainability. For social sustainability, 2017 is the best performance year and followed by 2018. Even though the firm has fluctuating results for environmental and social sustainability, considering higher values of the last year compared to others, it can be concluded that the firm is getting better on its sustainable activities. However, for environmental- and social-wise, there can be some additional policies that the firm may need to implement. Each firm has a different amount of ecological footprint. Paper usage, food waste from lunchtimes, emissions related to the use of nonrenewable energy, procurement, marketing, advertisement, supply chain process, hazardous waste generations, and so many factors



Fig. 7 Economic results (VIKOR results are subtracted from 1)

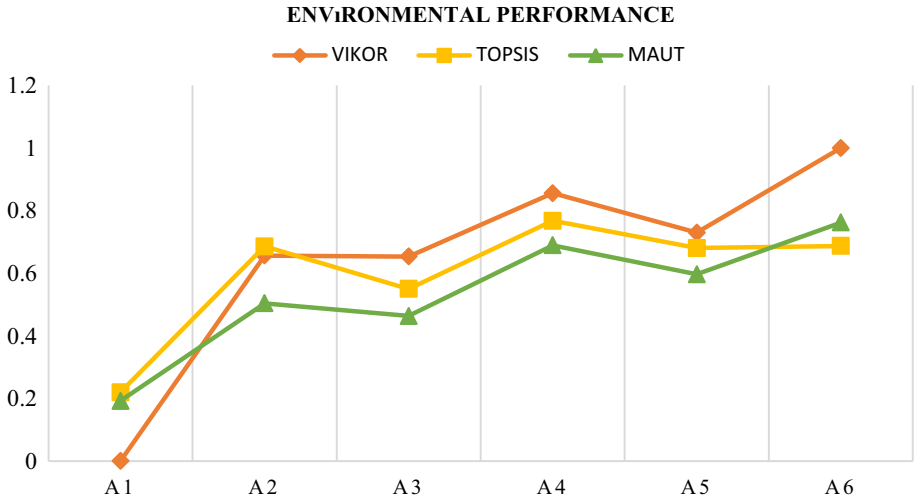


Fig. 8 Environmental results (VIKOR results are subtracted from 1)

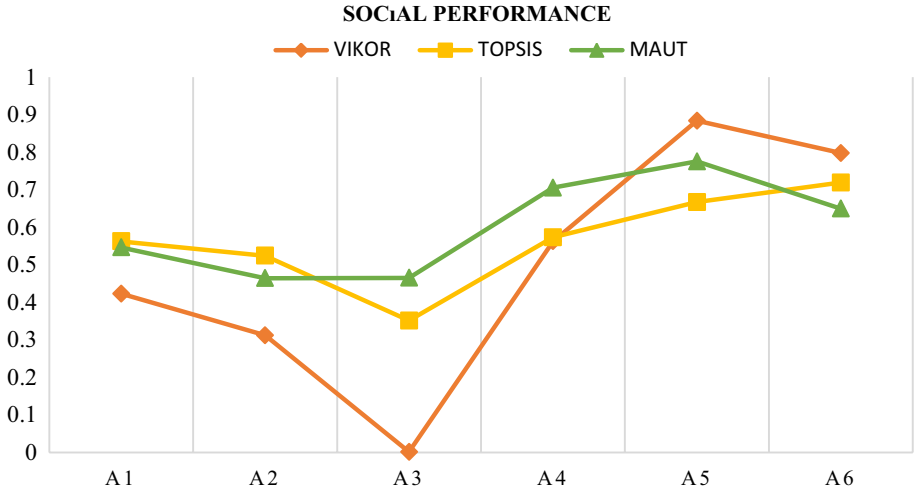


Fig. 9 Social results (VIKOR results are subtracted from 1)

Table 10 Borda Count ranking list

Ranking	Economic	Environmental	Social
1	2018	2018	2017
2	2017	2016	2018
3	2016	2017	2016
4	2015	2014	2013
5	2014	2015	2014
6	2013	2013	2015

are included in this process. To decrease ecological footprints and to avoid environmental and social harms that firms caused corporate environmental management activities are required. Consistent investments should be made in order to boost the sustainability performance for all three dimensions. Recycled product ratio, female personnel ratio, and criteria related to energy consumptions may be the criteria that the company needs to work and get better on according to the results. Inclusion of wastewater to the production besides the diversification of the measurement of greenhouse gas emission types and investments on solar and renewable energy can be considered by the firm to get its sustainability performance better. Organizational behavior related to sustainable development is based on the understandings, reasons, values and decisions of the individual participants (Wu et al., 2018). Firms should internalize their sustainability goals and act together with employees. An employee with environmental and social responsibility awareness is an essential resource that contributes to the improvement of the firm. The firm also needs to plan its sustainability activities rather than acting instantly based on the current year. Consistent sustainability performance provides better competitive advantage and long-term value for firms. It is a fact that the firm we have investigated in the study aims to improve sustainability performance by investing in R&D processes. Their process improvement regarding R&D consists of more environmentally friendly products, less production waste, less harmless and more health-friendly products, etc. By doing so, firm's waste generation is decreasing while its recycled product ratio is increasing. Therefore, this criterion may be separated into categories such as R&D investments for financial concerns, environmental concerns, and social concerns. Firms should advance their business patterns in order to accomplish increased industrial sustainability (Nicolăescu et al., 2015). Therefore, firms need to be aware of the fact that sustainability reports that contain more information and open to access are better to demonstrate their actions and make a good impression. Concentrating on sustainability provides firms to have a coherent policy that facilitates the embracing of best practices and intensifies performance.

5 Conclusion

Even though sustainability emerged in the field of forests and fisheries a long ago, it is still today's one of the crucial and even world-shaking topics. To be able to hand over a world that future generations can live efficiently in, it is vital that precautions should be taken from today. The importance and urgency of sustainable policies are now undeniable, and environmental disasters and social crises can be a wakeup call. We should make the best use of these periods of critical breaks and fend off any future catastrophe.

This paper aims to analyze and discuss a case study regarding corporate sustainability evaluation using MCDM techniques. In the literature, MCDM methods are popular tools to evaluate sustainability performance. Our purpose is gaining a deeper understanding of sustainability performance of organizations and obtaining reliable results via implementing several MCDM methods. By applying more than one method to a single problem, it is aimed to obtain robust results that assist decision-makers to make healthy and strategic decisions. The framework given in the study is justified by a real case considering the measuring sustainability performance of a firm operating in furniture sector in Turkey. Since the use of subjective or equal weights does not guarantee of the objectivity of the decision, entropy method has been used for determining the relative importance (weights) of the criteria. Entropy results show that the most important criterion

is "R&D Expenditure" for the economic dimension, "Amount of Recovered Waste" for the environmental dimension, and "Personnel Turnover Rate" for the social dimension. For ranking, VIKOR, TOPSIS, and MAUT have been implemented. Rankings of different MCDM methods are combined via the Borda count method which is a data fusion technique. Borda count method has been implied since it provides an integrated ranking from individual ranking sets based on the group consensus function in the context of group decision theory. Results show that 2018 is the best economic performance year for all methods. For the environmental and social performances, VIKOR and MAUT methods agreed on 2018 and 2017 have the best performance, while TOPSIS results show the years 2016 and 2018, respectively. Results of the Borda count method show that the company's economic performance is more stable compared to environmental and social performances. Although it is possible to say that the firm tends to improve sustainability performance as it has better performance results at current years, policies to improve the performance on environmental and social dimensions should be developed in order to get better conclusions.

Considering that the sustainability policies of the firms constitute the sustainability of the regions and countries and that the sustainability policies of the countries affect the remaining life of the world, raising awareness on corporate sustainability is absolutely vital. For this reason, governments also need to take action and ensure the firms apply sustainable practices. Governments may support sustainability activities with different policies such as tax exemption, incentives, supporting the most successful sustainability projects and activities. Apart from these, governments taking their own constraints into account should establish specific corporate sustainability frameworks within the scope of their sustainability goals. The lack of a specific national framework and political enforcements regarding sustainability causes firms not to take actions.

We hope that using 33 criteria of three dimensions for evaluating the sustainability performance with different MCDM methods and performing the process on a real-life case will assist decision-makers and practitioners in making integrated decisions for their sustainability and improving the quality and awareness of the sustainability reports. As a sector leader, the considered firm in this study has great importance for Turkey and affects not only its employees but also society. This study is expected to increase the awareness of consumers, stakeholders, and other companies about sustainable activities, sustainability performance, and sustainability reporting besides improving the relationship with stakeholders. Using only one company's data is the main limitation of the paper. Future research should examine more companies in the sector and comparison of different foreign and domestic companies' performances of sustainability. Applying sensitivity analysis by changing criteria weightings in order to test the sensitivity of the results of different methodologies and by adding more criteria in the analysis process considering fuzziness should be other extensions. Also, categories such as technology and energy could be added to the three basic sustainability dimensions for future studies to evaluate subcategories deeply under these dimensions.

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Declarations

Conflicts of interest The authors declare that they do not have any conflicts of interest.

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