ASSESSMENT OF SUSTAINABILITY COMPLIANCE PERFORMANCE OF INFORMATION TECHNOLOGY COMPANIES[1]

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Üzeyir FİDAN
Dr.
Uşak University
Distance Education Vocational School,
Uşak, Türkiye
uzeyir.fidan@usak.edu.tr
ORCID ID: 0000-0003-3451-4344

ABSTRACT | Today, the concept of sustainability is becoming increasingly important and a strategic priority for businesses. Measuring the sustainability performance of companies operating in the IT sector, which is experiencing rapid digital transformation, is of great importance. The aim of this study is to evaluate the sustainability compliance of companies listed on the BIST Information Technology Index using Entropy-based Grey Relational Analysis. Objectively measuring sustainability performance will facilitate decision-making for both companies and investors. In this study, weights of predetermined sustainability criteria are first calculated using the Entropy method. Then, Grey Relational Analysis is applied to analyze companies' sustainability performance and obtain rankings. According to both the raw scores and the results of the Grey Relational Analysis, Logo, Kafein and Alcatel companies were identified as the companies with the highest performance. The consistency of these results shows the validity of the applied method.

Keywords: *Sustainability, IT Management, MCDM*
JEL Codes: *M14, M15, C44*

Scope: *Management information systems*
Type: *Research*

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[1] It has been declared that the relevant study complies with ethical rules.

BİLİŞİM ŞİRKETLERİNİN SÜRDÜRÜLEBİLİRLİK UYUM PERFORMANSLARININ DEĞERLENDİRİLMESİ

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Üzeyir FİDAN
Dr.
Uşak Üniversitesi
Uzaktan Eğitim Meslek
Yüksekokulu,
Uşak, Türkiye
uzeyir.fidan@usak.edu.tr
ORCID ID: 0000-0003-3451-4344

ÖZ | Günümüzde sürdürülebilirlik kavramı, işletmeler açısından giderek daha fazla önem kazanmakta ve stratejik bir öncelik haline gelmektedir. Özellikle hızlı dijital dönüşüm yaşayan bilişim sektöründe faaliyet gösteren şirketlerin, sürdürülebilirlik alanındaki performanslarının ölçülmesi büyük önem arz etmektedir. Bu çalışmanın temel amacı, Borsa İstanbul Bilişim Endeksi'nde yer alan şirketlerin sürdürülebilirlik performanslarının, Entropi temelli Gri İlişkisel Analiz yöntemi kullanılarak değerlendirilmesidir. Sürdürülebilirlik performansının objektif ölçümü hem şirketler hem de yatırımcılar açısından karar verme sürecinde yararlı olacaktır. Çalışmada ilk olarak belirlenen sürdürülebilirlik kriterlerinin ağırlıkları Entropi yöntemi ile hesaplanmıştır. Daha sonra Gri İlişkisel Analiz yöntemi uygulanarak şirketlerin sürdürülebilirlik performansları analiz edilmiş ve sıralamalar elde edilmiştir. Hem ham puanlar hem de Gri İlişkisel Analizi sonuçlarına göre Logo, Kafein ve Alcatel şirketleri en yüksek performansa sahip şirketler olarak tespit edilmiştir. Bu sonuçların tutarlı olması, uygulanan yöntemin geçerliliğini göstermektedir.

Anahtar Kelimeler: *Sürdürülebilirlik, BT Yönetimi, ÇKKV*
JEL Kodları*: M14, M15, C44*

Alan: *Yönetim bilişim sistemleri*
Türü: *Araştırma*

1. INTRODUCTION

For businesses, sustainability practices are of great importance in terms of increasing operational efficiency by reducing environmental impacts and strengthening corporate reputation and brand value. Today, sustainability has become an issue of great importance for companies operating in almost all sectors. However, the IT sector, which is rapidly developing and undergoing constant change with the impact of digitalization, has some unique characteristics in terms of sustainability (Soma, Termeer & Opdam, 2016; Garetti & Taisch, 2012; Dao, Langella & Carbo, 2011). Companies in this sector have serious responsibilities to conduct their activities in a sustainable framework. First of all, IT itself has the potential to improve the sustainability performance of many other sectors (Gatautis, 2008). In this respect, it is crucial for IT companies to show leadership in sustainability. Moreover, the nature of the sector is characterized by high energy consumption (Elavarasan et al., 2023) and the amount of e-waste is increasing (Widmer et al., 2005). At this point, the transition to environmentally friendly and sustainable operation models is of vital importance.

Non-financial issues, especially environmental, social and governance factors in the area of sustainability, are becoming increasingly crucial for both companies and investors (Bassen & Kovács, 2020). For companies, these issues are critical for business continuity, operational efficiency, reputation management, innovation and competitiveness. For investors, these factors include significant risks and opportunities that are considered in investment decisions. The long-term value-creation capacity of companies is directly linked to these issues. Therefore, for both companies and investors, not only financial data but also environmental, social and governance performance affect investment decisions and valuations. Therefore, non-financial reporting and transparency are of great importance. Companies included in the Borsa Istanbul (BIST) sustainability index are obliged to regularly report their sustainability performance. In these reports, companies' environmental sustainability practices, social sustainability policies and activities, corporate governance and ethical business principles, sustainability strategies and targets should be disclosed. Reporting activities should be carried out on an annual basis and in accordance with the Global Reporting Initiative (GRI) or similar recognized standards. Independent audit is recommended, although not mandatory. Prepared reports should be openly shared with the public (Sustainability Indices, 2023). In this way, companies can demonstrate their transparency and accountability in the field of sustainability, and at the same time, important information is provided for investors in the decision-making process.

The purpose of this study is to evaluate the compliance performance of IT companies in the Borsa Istanbul IT Index in the field of sustainability. In the study, firstly, the concept of sustainability and its importance for the IT sector are analyzed. Then, the current situation of the companies in the BIST IT Index on environmental, social, and corporate sustainability issues is analyzed. By analyzing the sustainability reports and other public statements of the companies, the companies in the index are compared in terms of sustainability performance. The main motivation of this study is to analyze the sustainability performance of the companies in the BIST IT Index with objective criteria, to reveal the current situation of the sector in this field and to create a basis for companies to develop sustainability-oriented strategies. Information technologies play a role in supporting sustainability both for its sector and for other sectors. However, IT companies also need good practices and transformation in this regard. The companies included in the BIST IT Index represent the leading IT companies in Turkey. Analyzing the sustainability performance of these companies is important to see the general trends in the sector. Another motivation of the study is to develop policy recommendations for the future by revealing the successes and shortcomings of companies in the field of sustainability. In this way, it will be possible to identify what needs to be done for the IT sector to contribute to Turkey's sustainable development goals. It is thought that the results of the research will be useful for both academia and the sector.

In the remaining sections of the study, the literature on sustainability performance is summarized. Then, the methodology of the study is explained in detail. The following section presents the empirical findings and conclusions. The conclusion summarizes the main outcomes of the study and makes recommendations for future research.

2. SUSTAINABILITY CONCEPT AND RELATED WORKS

A sustainability report is a comprehensive summary of an organization's environmental, social and economic performance (Sebhatu, 2009). These reports reveal the organization's sustainability strategy, goals and performance. It also transparently presents the organization's sustainability efforts and commitments to its stakeholders: customers, employees, shareholders, investors, suppliers and society.

Sustainability reports usually cover the following topics (Székely & Vom Brocke, 2017):

Environmental performance: The organization's environmental performance, such as energy use, water use, waste management, combating climate change and protecting natural resources.

Social performance: The organization's social responsibilities towards its employees, local communities and society.

Economic performance: The organization's financial performance and investments in sustainability.

Sustainability reports are generally prepared according to the Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB) and The Climate Disclosure Standards Board (CDSB) standards (Basu, 2022).

Sustainability is the long-term maintenance of an organization's environmental, social and economic performance. Sustainability reports are reports that comprehensively summarize an organization's sustainability performance. These reports set out the organization's sustainability strategy, goals and performance. Sustainability reports provide significant benefits for listed companies in terms of increasing investor confidence, improving financial performance, gaining competitive advantage and strengthening corporate reputation. In conclusion, sustainability reports are an important communication tool for listed companies. Listed companies that want to benefit from this situation are expected to prepare their sustainability reports in accordance with the standards and share them regularly with their stakeholders.

The measurement and management of sustainability performance in businesses has received increasing attention in recent years. Sustainability is an approach that aims to balance environmental, economic and social goals. For businesses, sustainability is of great importance in terms of operational efficiency, risk management, reputation, competitive advantage and long-term value creation. Measuring, monitoring and reporting sustainability performance plays a critical role in achieving these goals. However, since sustainability is a multidimensional concept, performance measurement poses various challenges. It is vital to develop accurate and consistent performance indicators and collect data on environmental, social and governance issues (Gedik, 2020; Turhan et al., 2018).

Sustainability reporting is the reporting in which companies disclose their policies, objectives, performance and risks in environmental, social and corporate governance areas. International standards are widely used for sustainability reporting (Koçyiğit et al., 2023). However, there is still a need to improve the quality of reporting (Onocak et al., 2023). Qualitative and quantitative indicators should be developed to better measure sustainability performance (Hallstedt, 2017). In addition, integrated sustainability indices that combine different dimensions can be created. Studies show that there is a positive relationship between sustainability compliance and firm value (Kevser & Doğan, 2020). Sustainability reporting can also positively affect financial performance (KR &

Prasad, 2023). However, sustainability accounting practices and reporting have some challenges. There is a need to raise awareness among stakeholders on this issue (Juusola & Srouji, 2023).

Various approaches and tools for sustainability performance measurement have been proposed in the literature. The most widely used among these are the Sustainability Accounting Standards Board (SASB) standards, the Global Reporting Initiative (GRI) standards and the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) (Bose, 2020).

3. METHODOLOGY

3.1. Data Collection and Ethics

The data used in this study are compiled from the 2022 sustainability compliance reports (KAP Sürdürülebilirlik Raporları, 2022) of 30 companies in the Borsa Istanbul (BIST) IT Index. These reports are secondary data submitted by companies for open access on the Public Disclosure Platform (PDP). However, 5 companies that did not publish a sustainability report on PDP were excluded from the scope of the study. The study does not require any ethics committee approval due to the use of secondary data. Analyses of the data obtained were carried out within this scope.

The first step in Multi-Criteria Decision Making problems is to identify alternatives and evaluation criteria. In this study, firstly, possible alternatives for the decision-making problem and the criteria to be used in evaluating these alternatives are defined. For the problem of ranking the companies according to the scores obtained from sustainability compliance reports, the alternatives were determined as 25 companies in the BIST IT Index. Sustainability compliance performance, which is considered the dependent variable for each company, is analyzed under four main criteria. These main criteria are general principles, environmental principles, social principles and corporate governance principles. Based on a total of 33 sub-criteria and 58 items that make up the main criteria, the performance of the companies on each criterion was scored (Figure 1).

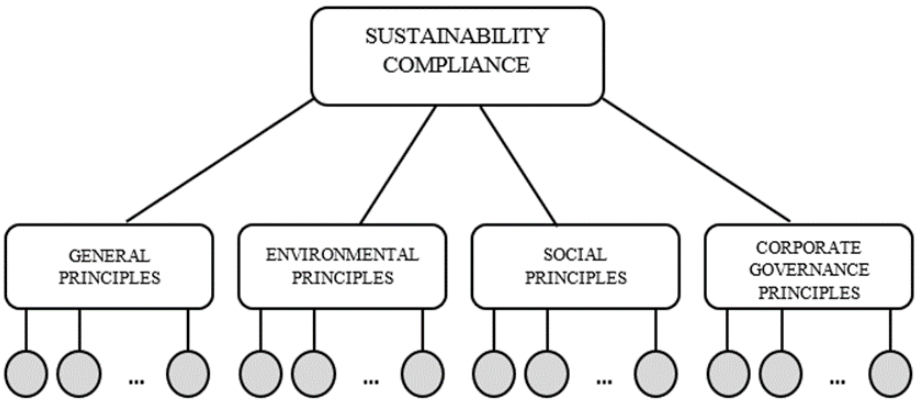

Figure 1: Sustainability Compliance Performance Model
Source: Created by the author using the PDP Sustainability Compliance form.

In the scoring process, the "Yes", "Partially", "No" and "Irrelevant" statements declared by the companies in accordance with the Public Disclosure Platform format were converted into numerical values and used.

3.2. Research Problem and Model

The main research problem of this study is to assess the sustainability performance of companies in the BIST IT Index in an objective and multidimensional manner. Scoring systems in existing sustainability indices are generally based on equal weighting or subjective methods. However, sustainability is a multidimensional concept and the importance levels of different criteria vary. Therefore, in this study, the environmental, social and corporate dimensions of sustainability will be discussed in detail and the weights of the criteria will be determined by objective methods. Thus, the current sustainability performance of companies can be analyzed more holistically and consistently. In this study, an entropy-based multi-criteria decision-making method is used to evaluate the sustainability performance of companies in the BIST IT Index. The model steps of the research are as follows:

- Sustainability compliance performance criteria are determined. The main criteria are general principles, environmental principles, social principles and corporate governance principles.
- For each criterion, sub-criteria and evaluation criteria are determined in accordance with the format used by the PDP.

- The data obtained from sustainability reports for companies are converted into numerical values on the basis of criteria.
- Criteria weights are determined with the Entropy Weight Method.
- Companies' sustainability performance scores are calculated using the Gray Relational Analysis method.
- Using the scores, companies are ranked according to performance.

3.3. Weighting Criteria

In this study, objective weighting was made by using the Entropy Weight Method for weighting sustainability criteria. Thus, consistent and objective weights independent of the subjective preferences of the decision-makers and/or the researcher can be obtained. The use of objective weighting provides a more valid and reliable assessment of sustainability performance. Less biased results can be obtained compared to subjective weighting (Fidan, 2022). At the same time, the consistency and comparability of the results of different researchers increases. Due to these advantages, an objective weighting approach was preferred in this study. The steps of the Entropy Weight Method (Shannon, 1948) used in the study are as follows:

1) Creating the Decision Matrix

In the Entropy Weight method, the criteria (indicators) and alternatives (examples) to be used in the evaluation are first defined. A matrix is created with each row representing an alternative and each column representing the criteria values of that alternative. Equation 1 shows the decision matrix (D) for n criteria and m alternatives.

$$D_{ij} = \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1n} \\ d_{21} & d_{22} & \cdots & d_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ d_{m1} & d_{m2} & \cdots & d_{mn} \end{bmatrix} \quad \textbf{(1)}$$

2) Normalization of Data

All data in the decision matrix are normalized with Equation 2.

$$N_{ij} = \frac{d_{ij}}{\sum_1^m d_{ij}} \quad \textbf{(2)}$$

3) Calculation of Entropy Values

The Entropy value for each criterion is calculated by Equation 3.

$$E_j = -\frac{\sum_1^m N_{ij}.\ln(N_{ij})}{\ln(m)} \quad \textbf{(3)}$$

4) Calculation of Entropy Weights

As a final step, the weights of the criteria are calculated with Equation 4 using the Entropy values obtained.

$$w_j = \frac{1-E_j}{\sum_1^n (1-E_j)} \quad \textbf{(4)}$$

3.4. Ranking Alternatives

There are many multi-criteria decision-making methods for ranking alternatives. In this study, Gray Relational Analysis (Liu, Forrest & Yang, 2012) integrated with the weights determined by EWM is used. Gray Relational Analysis is a method frequently used in decision problems involving uncertainty. The steps of the Gray Relational Analysis method are as follows:

1) Creating the Decision Matrix

This step was performed in the EWM process (see Equation 1).

2) Normalization of Data

Unlike the EWM, this step is performed by a method called min-max normalization (Equation 5).

$$n_i = \frac{d_i(j) - \min_j d_i(j)}{\max_j d_i(j) - \min_j d_i(j)} \quad \textbf{(5)}$$

3) Establishment of the Reference Series

$$X_{0j} = \big(n(j)\big) \quad \textbf{(6)}$$

The value calculated in Equation 6 shows the maximum value of criterion j in the normalized decision matrix.

4) Creating the Absolute Value Table

The absolute values of the differences between the values obtained in the reference series (X_{0j}) and the normalized values (n_{ij}) are calculated with Equation 7.

$$\Delta_{0i}= \left|X_{0j} - n_{ij}\right| \quad \textbf{(7)}$$

Thus, the matrix Δ is created (Equation 8).

$$\Delta= \begin{bmatrix} \Delta_{01}(1) & \Delta_{01}(2) & \cdots & \Delta_{01}(n) \\ \Delta_{02}(1) & \Delta_{02}(2) & \cdots & \Delta_{02}(n) \\ \vdots & \vdots & \cdots & \vdots \\ \Delta_{0m}(1) & \Delta_{0m}(2) & \cdots & \Delta_{0m}(n) \end{bmatrix} \quad \textbf{(8)}$$

5) Creating the Gray Relational Coefficient Matrix

Gray relational coefficients (γ) are calculated by Equation 9. In this Equation, ρ is called the discriminant coefficient and is set as a value in the range [0, 1].

$$\gamma_{0i}(j) = \frac{\Delta_{min}+\rho\,\Delta_{max}}{\Delta_{0i}(j)+\rho\,\Delta_{max}} \quad \textbf{(9)}$$

6) Calculation of Gray Relational Ranks and Ranking of Alternatives

Gray relational degrees (π) are calculated with Equation 10.

$$\pi_{0i} = \sum_{j=1}^{n}[w(j).\gamma_{0i}(j)] \quad \textbf{(10)}$$

In Equation 10, $w(j)$ indicates the weight of the relevant criterion calculated by EWM. The gray relational degrees obtained as a result of the Gray Relational Analysis are ranked from higher to lower and the alternatives are ranked.

4. RESULTS

4.1. Entropy Weight Method

In this study, in order to calculate the criteria weights using EWM, firstly, the textual data obtained from the sustainability reports of the companies published on the Public Disclosure Platform were converted into numerical data according to the scoring framework shown in Table 1. Thus, the sustainability performances of the companies within the scope of the relevant criteria were converted into a quantitative data set that can be used in the EWM. Quantification

of textual data constitutes one of the preliminary processes required for the objective determination of criteria weights.

Table 1: Scoring Sheet

	Yes	Partially	No	Irrelevant
Scoring	2	1	0	0

Following the quantification of the textual data, the scores of the companies on the basis of the relevant sub-criteria and items were summed according to the scoring framework shown in Table 1 and the total scores were calculated on the basis of the four main criteria. Thus, the total sustainability performance scores of each company under the main criteria of environmental, social, corporate governance and general principles were obtained. This stage was used to create the decision matrix required for the application of EWM. The total scores obtained and the scores normalized by Equation 2 are presented in Table 2.

Table 2: Sustainability Compliance Scores and Normalized Scores

	TOTAL SCORES				NORMALIZED SCORES			
	Cr1	**Cr2**	**Cr3**	**Cr4**	**Cr1**	**Cr2**	**Cr3**	**Cr4**
ALCTL	20,0000	26,0000	36,0000	4,0000	0,1105	0,1126	0,0800	0,0769
ARDYZ	0,0000	2,0000	0,0000	0,0000	0,0000	0,0087	0,0000	0,0000
ARENA	2,0000	0,0000	12,0000	2,0000	0,0110	0,0000	0,0267	0,0385
ATATP	6,0000	20,0000	22,0000	4,0000	0,0331	0,0866	0,0489	0,0769
DESPC	1,0000	0,0000	8,0000	1,0000	0,0055	0,0000	0,0178	0,0192
DGATE	1,0000	0,0000	8,0000	1,0000	0,0055	0,0000	0,0178	0,0192
EDATA	4,0000	0,0000	10,0000	2,0000	0,0221	0,0000	0,0222	0,0385
FONET	6,0000	0,0000	13,0000	0,0000	0,0331	0,0000	0,0289	0,0000
INDES	1,0000	0,0000	8,0000	1,0000	0,0055	0,0000	0,0178	0,0192
INGRM	2,0000	0,0000	2,0000	0,0000	0,0110	0,0000	0,0044	0,0000
KAREL	16,0000	33,0000	29,0000	3,0000	0,0884	0,1429	0,0644	0,0577
KAFEIN	20,0000	32,0000	32,0000	4,0000	0,1105	0,1385	0,0711	0,0769
KRONT	8,0000	3,0000	17,0000	4,0000	0,0442	0,0130	0,0378	0,0769
LINK	1,0000	0,0000	16,0000	0,0000	0,0055	0,0000	0,0356	0,0000
LOGO	21,0000	39,0000	36,0000	4,0000	0,1160	0,1688	0,0800	0,0769
MANAS	4,0000	1,0000	10,0000	2,0000	0,0221	0,0043	0,0222	0,0385
MIATK	19,0000	18,0000	32,0000	1,0000	0,1050	0,0779	0,0711	0,0192
MOBTL	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
MTRKS	3,0000	2,0000	17,0000	3,0000	0,0166	0,0087	0,0378	0,0577
NETAS	6,0000	13,0000	19,0000	2,0000	0,0331	0,0563	0,0422	0,0385
PAPIL	6,0000	12,0000	27,0000	4,0000	0,0331	0,0519	0,0600	0,0769
PENTA	12,0000	12,0000	34,0000	4,0000	0,0663	0,0519	0,0756	0,0769
PKART	4,0000	1,0000	14,0000	2,0000	0,0221	0,0043	0,0311	0,0385
SMART	18,0000	17,0000	30,0000	3,0000	0,0994	0,0736	0,0667	0,0577
VBTYZ	0,0000	0,0000	18,0000	1,0000	0,0000	0,0000	0,0400	0,0192

The criteria weights calculated with the help of Equation 1-4 are presented in Table3.

Table 3: Weights of the Criteria

	Cr1	**Cr2**	**Cr3**	**Cr4**
w	0,2335	0,4055	0,1668	0,1943

When the criteria weights obtained as a result of EWM are analyzed, it is seen that the environmental principles criterion has the highest weight with 0,4055. This shows that environmental sustainability stands out as the most important criterion in the evaluation of sustainability performance. The general principles criterion ranks second with a weight of 0,2335. Corporate governance principles rank third with a weight of 0,1943. The social principles criterion has the lowest weight with 0,1668. These weights reflect the multidimensional structure of sustainability performance and objectively reveal the level of importance of the dimensions. It is seen that environmental sustainability has a relatively higher priority.

4.2. Gray Relational Analysis

After determining the criteria weights with EWM, the next step is to evaluate and rank the sustainability performance of the companies in the BIST IT Index. For this purpose, Gray Relational Analysis method will be used in this study. Gray relational analysis is a method widely used in multi-criteria decision problems involving uncertainty. The sustainability performances of the companies will be evaluated and ranked with Gray Relational Analysis by taking into account the weights obtained with EWM.

The steps of creating the decision matrix, normalizing the data and creating the reference series are considered as the initial steps for GRA. As a result of these steps, the reference series was calculated as $Ref = \{1{,}000;\ 1{,}000;\ 1{,}000;\ 1{,}000\}$. The absolute values, gray levels and ranking results based on these values are given in Table 4.

Table 4: Ranking of Alternatives

	ABSOLUTE VALUE				GREY RELATIONAL				RESULTS	
	Cr1	Cr2	Cr3	Cr4	Cr1	Cr2	Cr3	Cr4	Grey Grade	Rank
ALCTL	0,0476	0,3333	0,0000	0,0000	0,9130	0,6000	1,0000	1,0000	0,8175	3
ARDYZ	1,0000	0,9487	1,0000	1,0000	0,3333	0,3451	0,3333	0,3333	0,3381	24
ARENA	0,9048	1,0000	0,6667	0,5000	0,3559	0,3333	0,4286	0,5000	0,3869	16
ATATP	0,7143	0,4872	0,3889	0,0000	0,4118	0,5065	0,5625	1,0000	0,5896	8
DESPC	0,9524	1,0000	0,7778	0,7500	0,3443	0,3333	0,3913	0,4000	0,3585	20
DGATE	0,9524	1,0000	0,7778	0,7500	0,3443	0,3333	0,3913	0,4000	0,3585	20
EDATA	0,8095	1,0000	0,7222	0,5000	0,3818	0,3333	0,4091	0,5000	0,3897	15
FONET	0,7143	1,0000	0,6389	1,0000	0,4118	0,3333	0,4390	0,3333	0,3693	18
INDES	0,9524	1,0000	0,7778	0,7500	0,3443	0,3333	0,3913	0,4000	0,3585	20
INGRM	0,9048	1,0000	0,9444	1,0000	0,3559	0,3333	0,3462	0,3333	0,3407	23
KAREL	0,2381	0,1538	0,1944	0,2500	0,6774	0,7647	0,7200	0,6667	0,7178	4
KAFEIN	0,0476	0,1795	0,1111	0,0000	0,9130	0,7358	0,8182	1,0000	0,8423	2
KRONT	0,6190	0,9231	0,5278	0,0000	0,4468	0,3514	0,4865	1,0000	0,5222	10
LINK	0,9524	1,0000	0,5556	1,0000	0,3443	0,3333	0,4737	0,3333	0,3593	19
LOGO	0,0000	0,0000	0,0000	0,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1
MANAS	0,8095	0,9744	0,7222	0,5000	0,3818	0,3391	0,4091	0,5000	0,3920	14
MIATK	0,0952	0,5385	0,1111	0,7500	0,8400	0,4815	0,8182	0,4000	0,6055	7
MOBTL	1,0000	1,0000	1,0000	1,0000	0,3333	0,3333	0,3333	0,3333	0,3333	25
MTRKS	0,8571	0,9487	0,5278	0,2500	0,3684	0,3451	0,4865	0,6667	0,4366	12
NETAS	0,7143	0,6667	0,4722	0,5000	0,4118	0,4286	0,5143	0,5000	0,4528	11
PAPIL	0,7143	0,6923	0,2500	0,0000	0,4118	0,4194	0,6667	1,0000	0,5716	9
PENTA	0,4286	0,6923	0,0556	0,0000	0,5385	0,4194	0,9000	1,0000	0,6401	5
PKART	0,8095	0,9744	0,6111	0,5000	0,3818	0,3391	0,4500	0,5000	0,3988	13
SMART	0,1429	0,5641	0,1667	0,2500	0,7778	0,4699	0,7500	0,6667	0,6267	6
VBTYZ	1,0000	1,0000	0,5000	0,7500	0,3333	0,3333	0,5000	0,4000	0,3741	17

In the study, the sustainability performances of 25 companies in the Borsa Istanbul Informatics Index were evaluated and ranked using the Gray Relational Analysis method. According to the results of the analysis, the top three companies with the highest sustainability performance are LOGO, KFEIN and ALCTL, respectively. These three companies stand out as having the best practices in terms of environmental, social and corporate sustainability criteria. At the other extreme, INGRM, ARDYZ and MOBTL were the last three companies among the 25 companies. It is concluded that the sustainability performance of these companies is relatively low in terms of the criteria addressed. The ranking obtained reveals the current situation of companies operating in the IT sector.

4.3. Sensitivity Analysis

In Multi-Criteria Decision-Making problems, it can be seen that in some cases the results obtained (ranking) may be affected by the parameter values (e.g. criterion weights) predetermined by the decision maker. For this reason, it is important to perform sensitivity analysis to test the consistency and reliability of the results. In sensitivity analysis, the values of critical parameters are deliberately changed and the effect of this change on the results is examined. If the results are significantly affected by small parameter changes, the stability of the solution is low. In this study, sensitivity analyses were performed to investigate the effect of criterion weights and discriminant coefficients on the results. Thus, the robustness of the solution is tested.

The value of the discriminant coefficient (ρ) used in the gray relational analysis was accepted as 0,5. Figure 2 shows the change in the ranking of the alternatives when this value is changed.

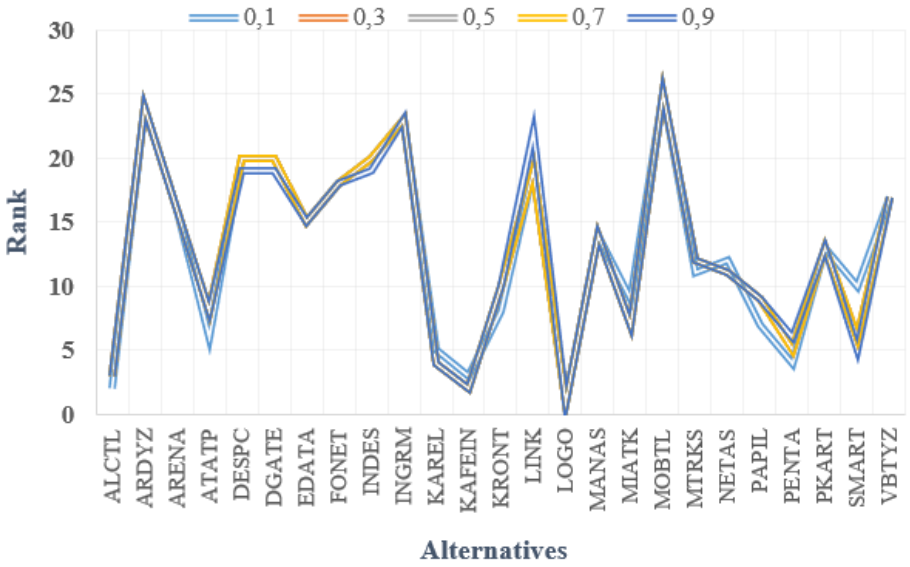

Figure 2: Sensitivity Analysis for the Discriminant Coefficient

As a result of the sensitivity analysis, it was observed that the change in the coefficient of discrimination (ρ) used in the gray relational analysis method did not have a determinant effect on the ranking results of the alternatives. The coefficient of discrimination can take values ranging between 0 and 1. In the analysis, the rankings obtained for different values of this coefficient between 0,1 and 0,9 were compared. Despite the change in the coefficient, there were no significant differences in the relative rankings of the alternatives, and the alternatives ranked higher in the overall ranking were similarly identified as having the best performance. These results show that the solution obtained by gray relational analysis is consistent and robust and reflects the sustainability performance of the alternatives independently of subjective parameters.

The criteria weights used in the Gray Relational Analysis were determined by EWM. The change in the ranking of the alternatives when the Equal weighting method, which is frequently used in the literature in the process of determining the weights, is shown in Figure 3.

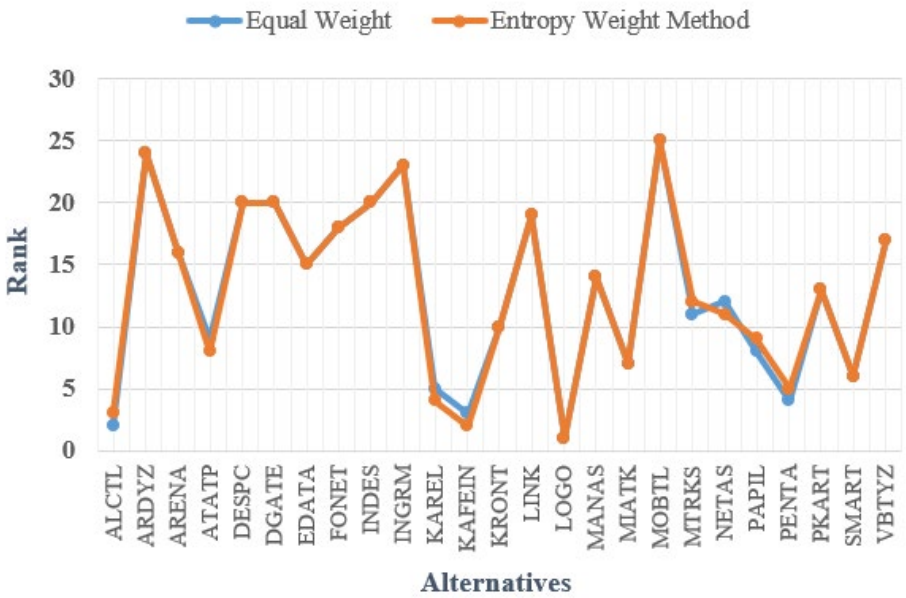

Figure 3: Sensitivity Analysis for Determining Criteria Weights

In another stage of the sensitivity analysis, the effect of the method used to determine the criteria weights on the ranking results of the alternatives was examined. For this purpose, the ranking results obtained by using the equal weight approach instead of the entropy method were compared. In the equal weight method, all criteria were assigned equal importance and weights were determined equally. In the comparison, it was observed that the alternative rankings obtained by both methods were very similar. Determination of criterion weights by different methods did not lead to significant differences in the relative rankings of the alternatives. This shows that the results obtained by Gray Relational Analysis are consistent and reliable.

5. CONCLUSION

Within the scope of the study, it is seen that the concept of sustainability is becoming increasingly important for businesses and that this issue has become a strategic priority, especially in rapidly digitalizing sectors. In this context, the importance of sustainability performance measurement in the IT sector, which is closely related to most sectors, will continue to increase. In this study, Gray Relational Analysis, one of the Multi-Criteria Decision-Making methods, was used in an integrated manner with the Entropy Weighting Method in performance

measurement. In this way, both the criteria weights and the ranking of alternatives were obtained objectively.

When the raw scores obtained from the data are evaluated, it is observed that Logo, Alcatel and Kafein received the highest scores in general principles performance, Logo, Karel and Kafein in environmental principles performance, Alcatel, Logo and Penta in social principles performance, and finally Alcatel, Atp, Kafein, Kron, Logo, Papil and Penta in corporate governance principles performance. According to the results of EWM-based Gray Relational Analysis, Logo, Kafein and Alcatel companies received the highest scores and achieved the top three rankings. These results demonstrate the consistency of the results of EWM-based Gray Relational Analysis.

The raw scores indicate that Logo, Alcatel and Kafein achieved the highest scores in general principles performance; Logo, Karel and Kafein in environmental principles performance; Alcatel, Logo and Penta in social principles performance; and Alcatel, Atp, Kafein, Kron, Logo, Papil and Penta in corporate governance principles performance. When the results of the EWM-based Gray Relational Analysis are analyzed, it is seen that Logo, Kafein and Alcatel companies rank first, second and third, respectively. The fact that the ranking obtained by EWM-based Gray Relational Analysis is consistent with the distribution of raw scores proves the validity and reliability of the results of the proposed method. The findings of the analysis support each other and allow consistent inferences to be made about the sustainability performance of the analyzed companies.

Although there are studies on sustainability performance measurement in the literature, studies specific to the IT sector are limited. Thanks to the proposed method, the study has enabled IT companies to objectively evaluate their sustainability performance. The results obtained provide useful information both to the academic literature and to companies and investors in the sector.

5.1. Managerial Implications

The following managerial implications can be drawn for this study:

- Companies operating in the IT sector should give strategic priority to sustainability. Sustainability-related policies and practices should be adopted company-wide.
- Companies should regularly measure and monitor their sustainability performance. In this way, weaknesses and strengths can be identified.
- Multi-Criteria Decision-Making methods provide objective and consistent results in sustainability performance measurement. Companies may consider using such methods.

- The sustainability performance results obtained can be used to identify areas for improvement and decision-making within the company.
- For investors, the sustainability performance of companies should be taken into account in investment decisions.
- Good practices in sustainability in the sector and across the country should be encouraged.
- Training and awareness-raising activities should be carried out to raise awareness on sustainability.
- The main managerial implication of this study is to emphasize the importance that IT companies attach to sustainability and their performance in this regard. Sustainability has become a strategic element that provides competitive advantage.

5.2. Implications for Future Research

Within the scope of this study, the following suggestions can be made for future research:

- The study can be repeated on companies operating in different sectors. Thus, a comparison between sectors can be made.
- Different multi-criteria decision-making methods (AHP, TOPSIS, VIKOR, etc.) can be used to compare the results.
- Critical factors affecting sustainability performance can be identified and the relationship between these factors and performance can be investigated.
- The relationship between internal practices and processes and sustainability performance can be examined.
- Deficiencies and errors in sustainability reporting can be investigated and suggestions can be developed to improve the quality of reporting.

6. CONFLICT OF INTEREST DECLARATIONS

There is no conflict of interest as the study is single-authored.

7. ACKNOWLEDGEMENT FOR FUNDING

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8. AUTHOR CONTRIBUTIONS

The entire study was conducted by a single author.

9. ETHICS COMMITTEE STATEMENT AND INTELLECTUAL PROPERTY COPYRIGHTS

Ethics committee principles were followed in the study. No permission was required within the scope of intellectual property and copyrights.

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