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Measuring sustainability performance with SWARA-MEREC-COBRA multi-criteria model: A case study of Anadolu insurance company

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CHRONICLE

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ABSTRACT

The aim of this study is to assess and rank Anadolu Sigorta Company's sustainability performance between 2018 and 2022 using the hybrid SWARA-MEREC-COBRA model. The sustainability performance evaluation criteria's importance weights were determined using both subjective and objective methods. The SWARA algorithm was used to determine the weights subjectively based on expert opinion, while the MEREC algorithm was used to determine them objectively. The final importance weights were obtained by combining the results of both methods. When evaluating the sustainability performance of Anadolu Sigorta Company, the most important criterion was total paper consumption, while the criterion with the least impact was the number of female employees. The COBRA ranking algorithm was used to rank the alternatives, and it was determined that the company's best sustainability performance was in 2022, while the worst was in 2018. Different sensitivity analyses were used to test the consistency of the proposed model.

1. Introduction

Sustainability is a widely discussed topic in various aspects of human life. It refers to a society's ability to meet the needs of the present generation while also considering the needs of future generations (Özevin, 2022). There is a growing recognition that companies should prioritize sustainability. However, there have been discussions about the institutional dimension of sustainability and the different definitions of corporate sustainability. One definition is that a company integrates social and environmental concerns into its business conduct and interactions with stakeholders (Searcy, 2012). Corporate sustainability is a business and investment strategy that aims to meet the needs of a company's current and future stakeholders while establishing a balance between them, as defined by the United Nations World Commission on Environment and Development Report (1987).

The insurance industry is a crucial component of the country's financial system. Insurance companies serve various social and economic functions, including minimizing the impact of financial losses resulting from various events, reducing uncertainty and fear, creating financial resources, and generating new business opportunities. The insurance sector's performance has a significant impact on the evolution of other sectors and the country's economy (Gunawardhane et al., 2022; Taşcı & Akbalık, 2022). Therefore, it is crucial to measure its performance, considering its various functions. Economic development is directly related to social, human, and environmental development. It is an undeniable fact that the insurance sector has a significant impact on sustainable development, and it is also of great importance for country economies (Scholtens, 2011).

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In today's highly competitive environment, companies are increasingly analysing participation in activities that promote sustainable development as a source of competitive advantage. To stand out, companies need to move beyond economic performance and focus on corporate sustainability performance, which includes social and environmental functions. (Lourenço et al., 2012). To accurately assess a business's sustainability performance, it must be evaluated across three dimensions: economic, environmental, and social. The economic dimension pertains to the profitability and financial stability of the business. The social dimension involves providing a high-quality living and working environment for employees, as well as considering the quality of life for society, customers, and future generations. The environmental dimension is concerned with the company's responsibility to avoid harming the environment or to minimize any damage caused by its activities (Ömürbek et al., 2017).

It is seen that studies on measuring the performance of insurance companies are generally carried out using only financial data. However, in today's challenging competitive conditions in the insurance industry, it is important to address economic factors as well as social and environmental factors. In our country, some insurance companies have participated in the sustainable development process in recent years and started to publish annual sustainability reports. The aim of this study is to propose a hybrid decision model consisting of SWARA-MEREC-COBRA methods in evaluating corporate sustainability performance in the insurance sector. To test the proposed model, we evaluated the corporate sustainability performance of Anadolu Insurance Company. Anadolu is Turkey's first national insurance company and has been publishing sustainability reports since 2018. We used environmental, economic, and social performance indicators to evaluate the period from 2018 to 2022. Below are the contributions of this study to the literature:

1. No studies on sustainability performance in the insurance sector have been found in the international literature. The majority of previous studies have focused on the financial performance of the insurance sector. This study focuses on the sustainability performance of an insurance company, based on environmental, social, and financial indicators.

2. The SWARA and MEREC algorithms were used to determine the environmental, social, and financial indicators that impact the sustainability performance of insurance companies. The results were obtained separately from subjective and objective perspectives and combined using a common weighting algorithm to obtain more optimal weights.

3. The study employed the COBRA ranking algorithm, a current MCDM approach, for the first time in performance measurement in the insurance industry.

4. The proposed hybrid sustainability performance evaluation model was used to obtain results, which were then tested through a comprehensive comparison and sensitivity analysis.

The study is organized as follows: the next section mentions previous literature on the evaluation of corporate sustainability performance. The third section explains the MCDM methods included in the proposed hybrid model and the study's dataset. The following section presents the application and findings. The final section of the study includes results, suggestions, and limitations.

2. Literature Review

The national literature review did not reveal any previous studies that measured corporate sustainability performance in the insurance sector. Typically, studies measuring performance in this sector rely solely on financial data. This study presents some sample studies that use MCDM methods to evaluate corporate sustainability performance. Table 1 also includes some sample studies that use SWARA, MEREC, and COBRA methods.

Oztel et al. (2012) aimed to measure the corporate sustainability performance of Henkel using the compromise programming framework of MCDM methods. The study focused solely on the environmental and social sustainability performance of the company. The data used in the analysis of Henkel, covering the period 2008-2011, was compiled from the company's annual reports. The study findings indicated an overall upward trend in Henkel's corporate sustainability performance. Based on the analysis, the consensus programming method appears to be a suitable tool for measuring corporate sustainability performance.

In their 2013 study, Govindan et al. (2013) evaluated supplier selection based on sustainability performance using 4 social, 4 environmental, and 4 economic criteria. The data was analyzed using the Fuzzy TOPSIS method, which concluded that supplier 3 had the best sustainability performance.

Goyal and Rahman (2014) aimed to develop a model to measure the corporate sustainability performance of the oil and gas industry. The sustainability performance of the business was evaluated using social, environmental, and economic criteria with the AHP method. The analysis revealed a slight improvement in the company's sustainability performance. It has been suggested that the model can be used to analyse corporate sustainability performance in relation to long-term competitive advantage.

Özçelik and Avcı (2014) aimed to measure the sustainability performances of banks with the Gray Relational Analysis method in their study. In their study, 3 financial, 4 environmental and 2 social ratios from the 2011 sustainability reports of

3 banks were used and the banks were ranked according to their sustainability performance. As a result of the analysis, it was determined that TSKB bank ranked first in terms of sustainability performance and Akbank ranked last.

Alp et al. (2015) aimed to evaluate the corporate sustainability performance of a company operating in the chemical industry by using the ENTROPY and MAUT methods, which are MCDM methods. The data to be used in the study were obtained from the company's sustainability reports for the period 2009 - 2012. As a result of the analysis, it was determined that the environmental performance of the company showed an unstable appearance, while its social and economic performance increased.

Table 1
Literature Review of SWARA, MEREC and COBRA Methods

Some Case Studies Using the SWARA Method	
Author	**Problem**
Alimardani et al. (2013)	Supplier selection
Stanujkic el al. (2015)	Packaging design selection
Zolfani et al. (2015)	Selection of R&D projects
Karabašević et al. (2016)	Personnel selection
Karabašević et al. (2016)	Ranking of Companies Based on Corporate Social Responsibility Indicators
Urosevic et al. (2017)	Personnel selection in the tourism industry
Veskovic et al. (2018)	Evaluation of the railway management model
Gök Kısa and Ayçin (2019)	Evaluation of Logistics Performance in OECD Countries
Akcan and Taş (2019)	Green Supplier Evaluation
Ayyıldız et al. (2020)	Performance analysis of wastewater treatment plants
Maruf and Özdemir (2021)	Evaluation of commercial banks' website performance
Elmas and Özkan (2021)	Evaluation of the financial performance of companies in the transportation and storage sector
Terzioğlu et al. (2022)	Financial performance evaluation in the energy sector
Güneş (2023)	Evaluation of cryptocurrency exchanges
Utlu (2023)	Digital marketing strategy selection
Some Case Studies Using the MEREC Method	
Rani et al. (2021)	Selection of technology for treating food waste
Ghorabaee (2021)	Location-based selection of distribution centres
Ayçin and Arsu (2021)	Evaluation of countries' social development ındex
Mishra el at. (2022)	Evaluation of Low Carbon Tourism Strategy
Ecer and Zolfani (2022)	Assessing Economic Freedom in OPEC Countries
Mastilo el at. (2023)	Evaluation of the banking sector in Bosnia and Herzegovina
Zhang et al. (2023)	Stock ınvestment selection
Lukic (2023)	Performance analysis of the Serbian economy
Puska et al. (2023)	Electric car selection ıssue
Kara et al. (2024)	Determining the level of sustainable competitiveness
İnce et al. (2024)	Comparison of logistics performance among G20 Countries
Taşcı and Akbalık (2024)	Evaluating the impact of company mergers on company performance
Some Case Studies Using the COBRA Method	
Krstić et al. (2022)	Evaluation of logistics 4.0 technologies in the agri-food sector
Verma et al. (2022)	Circular supplier selection
Popović et al. (2022)	Selecting an e-commerce development strategy
Krstić et al. (2022)	Evaluation of ındustry 4.0 technologies
Oğuz and Satır (2024)	Assessing profitability performance in retail companies
Krstić et al. (2024)	Assessing risks in the agri-food supply chain
Verma et al. (2024)	Cybersecurity platform evaluation

HSU et al. (2015), in their study, to create sustainable performance evaluation criteria and model. For this purpose, 2011 data of 30 high-technology companies operating in Taiwan were used. TOPSIS method was used to analyze the data. Analysis results show that among 30 high-technology companies operating in Taiwan in 2011, the performance ranking of the top five companies is C10, C20, C24, C19 and C26. The sustainability performance ranking of the worst five is C8, C15, C18, C27 and C17. Ömürbek et al. (2017) aimed to evaluate the sustainability performances of banks with different MCDM methods in their study. For this purpose, data included in the activity reports and sustainability reports published by banks were used. Among the criteria used to evaluate sustainability performance according to the ENTROPY method, the criterion with the highest importance was determined as the scope 2 emission criterion. According to the results of ARAS, MOOSRA and COPRAS methods, it was determined that Ziraat Bank ranked first in terms of corporate sustainability performance in all three methods. Aras et al. (2018) aimed to examine multidimensional corporate sustainability practices and create a corporate sustainability performance evaluation model for Turkish banks in their study. Sustainability reports published by four Turkish deposit banks between 2012 and 2014 were used to obtain data in the study. TOPSIS method was used to analyze the data. Analysis results revealed that each bank has different performance scores every year. Yalçın and Karakaş (2019) aimed to evaluate the corporate sustainability performance of an energy company traded on BIST. For this purpose, the company's social, environmental and economic criteria for the period 201-2018 were used in performance evaluation. An integrated model consisting of CRITIC and EDAS methods has been proposed to evaluate corporate sustainability performance. As a result of the analysis, it was stated that the company's corporate sustainability performance did not display a stable appearance. It has also been argued that the proposed model is suitable for evaluating corporate sustainability performance. Ecer (2019) used an integrated MCDM method consisting of ENTROPY and ARAS methods in his study, in which he aimed to measure the corporate sustainability performance of

private capital banks operating in Turkey. Study findings showed that the proposed model is appropriate to use in analyzing the corporate sustainability performance of banks. Additionally, as a result of the analysis, it was determined that the social dimension is the most important dimension in determining the sustainability performance of private capital banks. Beiragh et al. (2019) aimed to measure the corporate sustainability performance of insurance companies operating in Iran in their study. 8 economic, 3 environmental and 4 social indices were used to evaluate the corporate sustainability performance of insurance companies. AHP and Data Envelopment Method were used to analyze the data. Study findings revealed that Dana, Razi and Dey insurance companies have the best sustainability performance. Korzeb et al. (2019) aimed to evaluate the sustainability performance in the Polish banking sector in the 2015-2017 period in their study. TOPSIS multi-criteria decision making method was used in the study. As a result of the analysis, a decline in the sustainability performances of banks was detected during the examined period.

In his study, Özevin (2022) aimed to measure the sustainability performance of companies using 4 economic, 4 social and 4 environmental performance criteria using ENTROPY and TOPSIS methods. In the study, data from 12 companies included in the BIST sustainability index for the years 2017, 2018 and 2019 were used. The analysis determined that economic criteria accounted for 42% of the effectiveness in determining the sustainability performance of companies, while social and environmental criteria accounted for 32% and 26%, respectively.

3. Methodology

In this section, the SWARA-MEREC-COBRA hybrid MCDM model proposed to evaluate the corporate sustainability performance of Anadolu Sigorta Company is explained. Many subjective and objective MCDM methods are used in the literature to determine the importance weights of evaluation criteria. In this study, it was suggested to use a subjective (SWARA) and an objective (MEREC) MCDM method in weighting the evaluation criteria in order to use the advantages of both methods togetherIn solving decision problems based on a large number of evaluation criteria, making fewer pairwise comparisons in the SWARA method compared to other methods can be shown as an advantage of the method (Gök Kısa & Ayçin, 2019). In addition, SWARA can be described as a method that is simple to use and very suitable for working with experts (Özbek & Demirkol, 2018). The fact that the MEREC method is an up-to-date method, easy to calculate and understand, and has a solid mathematical infrastructure was effective in its preference (Ecer & Ayçin, 2023). In the study, the COBRA method was recommended for evaluation and ranking of alternatives. COBRA method is one of the distance-based MCDM methods such as TOPSIS and VIKOR, which are based on the comprehensive distances of criteria and alternatives to various solutions. The main advantage of the method compared to other distance-based methods is that it includes euclidean and taxicab distances from positive and negative ideal and average solutions (Krstić et al., 2024).

The corporate sustainability performance evaluation model proposed in the study is designed as shown in Fig. 1.

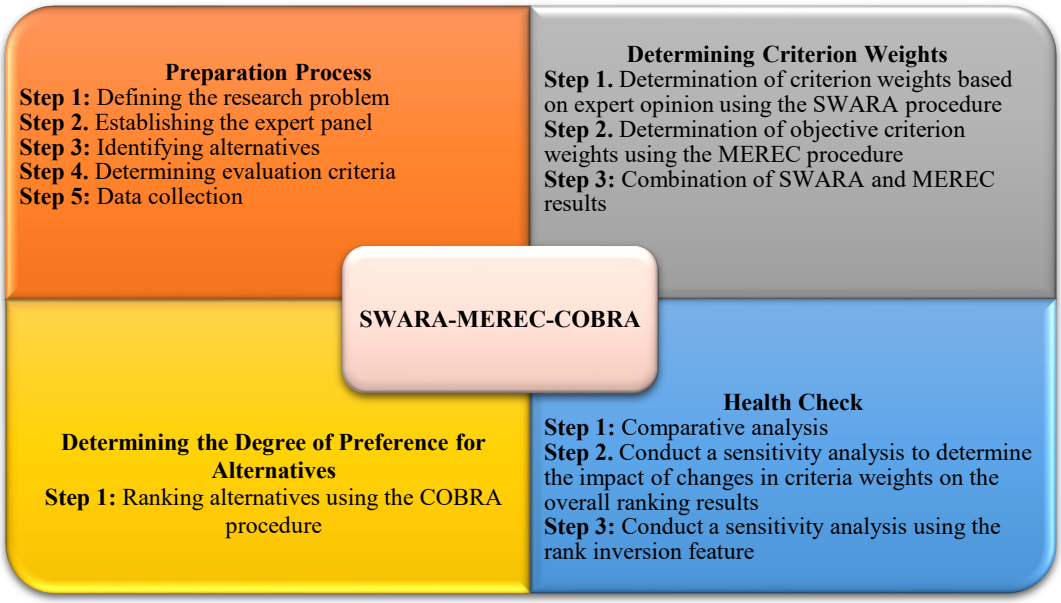

Fig. 1. Flow Chart of the Study

3.1. SWARA Method Calculation Procedure

The SWARA method, introduced to the literature in 2010 by Keršuliene et al., is a criterion weighting method based on expert opinions (Gök Kısa and Ayçin, 2019). The method's calculation steps are summarised as follows: (Zavadskas et al., 2018; Stanujkic et al., 2015):

Step 1: The criteria are ranked by experts based on their importance, with the most important criterion listed first and the least important listed last.

Step 2: Experts evaluate the importance of each criterion compared to the previous one (j-1) using a comparative average value (S_J) (Keršuliene vd., 2010).

Step 3: Eq. (1) is used to determine k_j coefficients for each criterion.

$$k_j = \begin{cases} 1 & j = 1 \\ s_j + 1 & j > 1 \end{cases} \tag{1}$$

Step 4: Calculate the new weight value q_j by applying Eq. (2).

$$q_j = \begin{cases} 1 & j = 1 \\ \frac{q_{j-1}}{s_j} & j > 1 \end{cases} \tag{2}$$

Step 5: Eq. (3) is used to calculate the relative weights of the evaluation criteria.

$$W_j = \frac{q_j}{\sum_{k=1}^{n} q_k} \tag{3}$$

3.2. Calculation Procedure for the MEREC Method

Keshavarz-Ghorabaee et al. (2021) propose a method where the weight coefficient of a criterion is determined by the change in the total weights of the evaluation criteria. The method has a solid mathematical basis, and the MEREC procedure involves the following mathematical steps (Ecer and Pamucar, 2022; Ghorabaee et al., 2021; Işık, 2022):

Step 1: A decision matrix containing n alternatives and m criteria is created. The elements of the decision matrix must be greater than zero. In case of a negative value, it should be converted to positive values with an appropriate technique.

$$\text{X}= \begin{bmatrix} X_{11} & \dots & X_{1j} & \cdots & X_{1n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ X_{m1} & \dots & X_{mj} & \dots & X_{mn} \end{bmatrix} \tag{4}$$

Step 2: Eq. (5) is used to normalize the decision matrix.

$$n_{ij}^{x}= \begin{cases} \frac{min_{xij}}{xij} if\ j \in benefit\ criterion \\ \frac{x_{ij}}{maks_{xij}}\ if\ j \in cost\ criterion \end{cases} \tag{5}$$

Step 3: Eq. (6) is used to determine the overall performance value (S_i) of the alternatives.

$$S_i = \ln\left(1 + \left(\frac{1}{m}\sum_j \left|\ln\left(n_{ij}^{x}\right)\right|\right)\right) \tag{6}$$

Step 4: Eq. (7) is used to calculate the performance of the alternatives (S'_{ij}) after removing each criterion from the set separately.

$$S'_{ij} = \ln\left(1 + \left(\frac{1}{m}\sum_{k,k\neq j} \left|\ln(n_{ik}^{x})\right|\right)\right) \tag{7}$$

Step 5: Calculate the sum of absolute deviations (E_j) using Eq. (8). Measure the impact of removal on the criterion based on the values obtained from step 3 and step 4.

$$E_j = \sum_i \left|S'_{ij} - S_i\right| \tag{8}$$

Step 6: The final weights of the criteria are calculated using the E_j value in Eq. (9).

$$W_j = \frac{E_j}{\sum_k E_k} \tag{9}$$

3.3. Weight Combining Operator

Eq. (10) combines the criterion weights obtained through SWARA and MEREC procedures using a combination operator based on the weighted average (Işık et al., 2022; Torkyesh et al., 2021).

$$W_{j,combined} = \frac{W_{j,SWARA} W_{j,MEREC}}{\sum_{J=1}^{m} W_{j,SWARA} W_{j,MEREC}} \tag{10}$$

3.4. COBRA Method Calculation Procedure

The COBRA method, proposed by Krstić et al. (2022), is an updated MCDM method used to determine the final ranking of alternatives. The method's calculation steps are as follows (Krstić et al., 2022; Popovic et al., 2022):

Step 1: Create a decision matrix according to Eq. (4).

Step 2: Eq. (11) is used to create the normalized decision matrix (Δ).

$$\Delta = \left[\alpha_{ij}\right]_{nxm} \tag{11}$$

$$\alpha_{ij} = \frac{\alpha_{ij}}{\max_i \alpha_{ij}} \tag{12}$$

Step 3: Create the weighted normalized decision matrix using Eq. (13).

$$\Delta_w = \left[w_j x \alpha_{ij}\right]_{nxm} \tag{13}$$

Here w_j j. represents the relative weight of the criterion.

Step 4: Calculate the positive ideal (PIS_j), negative ideal (NIS_j) and average solution (AS_j) for each criterion function using Eqs. (14-16), respectively.

$$PIS_j = \max_i (w_j x \alpha_{ij}) \, , j = 1, \dots \dots , m \text{ If the criterion is benefit} \tag{14a}$$

$$PIS_j = \min_i (w_j x \alpha_{ij}) \, , j = 1, \dots \dots , m \text{ If the criterion is cost} \tag{14b}$$

$$NIS_j = \min_i (w_j x \alpha_{ij}) \, , j = 1, \dots \dots , m \text{ If the criterion is benefit} \tag{15a}$$

$$NIS_j = \max_i (w_j x \alpha_{ij}) \, , j = 1, \dots \dots , m \text{ If the criterion is cost} \tag{15b}$$

$$AS_j = \frac{\sum_{i=1}^{n} (w_j x \alpha_{ij})}{n} \, , j = 1, \dots \dots , m \text{ for benefit and cost criteria} \tag{16}$$

Step 5: Step 5: Calculate the distances to the positive ideal $\left(d\left(PIS_j\right)\right)$ and negative ideal $\left(d\left(NIS_j\right)\right)$solutions for each alternative, as well as the positive distances to the average solution $\left(d\left(AS_j^{+}\right)\right)$and negative distances to the average solution $\left(d\left(AS_j^{-}\right)\right)$.

$$d\left(s_j\right) = dE\left(S_j\right) + \sigma \; x \; dE\left(S_j\right) \; x \; dT\left(S_j\right) \, , j = 1, \dots \dots , m \tag{17}$$

Here S_j represents any solution (PIS_j, NIS_j, AS_j) temsil etmektedir. σ is the correction coefficient. It is calculated via Eq. (18).

$$\sigma = \max_i dE\left(S_j\right)_i - \min_i dE\left(S_j\right)_i \tag{18}$$

Here, $dE\left(S_j\right)_i$ and $dT\left(S_j\right)_i$ represent the Euclidean and Taxicab distances, respectively. They are calculated using Eqs. (19-20) for the positive ideal solution and Equations (21) and (22) for the negative ideal solution.

$$dE\left(PIS_j\right)_i = \sqrt{\sum_{j=1}^{m} \left(PIS_j - w_j x \alpha_{ij}\right)^2} , i = 1, \dots \dots , n \; j = 1, \dots \dots , m \tag{19}$$

$$dT\left(PIS_j\right)_i = \sum_{j=1}^{m} \left|PIS_J - w_j x \alpha_{ij}\right| \, , i = 1, \dots \dots , n \; j = 1, \dots \dots , m \tag{20}$$

$$dE\left(NIS_j\right)_i = \sqrt{\sum_{j=1}^{m} \left(NIS_j - w_j x \alpha_{ij}\right)^2} , i = 1, \dots \dots , n \; j = 1, \dots \dots , m \tag{21}$$

$$dT\left(NIS_j\right)_i = \sum_{j=1}^{m} \left|NIS_J - w_j x \alpha_{ij}\right| , i = 1, \dots \dots , n \; j = 1, \dots \dots , m \tag{22}$$

Eqs (23-26) are used to calculate Euclidean and Taxicap distances for positive and negative deviations from the average solution.

$$dE\left(AS_j\right)_i^{+} = \sqrt{\sum_{j=1}^{m} \tau^{+} \left(AS_j - w_j x \alpha_{ij}\right)^2} \, , i = 1, \dots \dots , n \; j = 1, \dots \dots , m \tag{23}$$

$$dT\left(AS_j\right)_i^{+} = \sum_{j=1}^{m} \tau^{+} \left|AS_J - w_j x \alpha_{ij}\right| \, , i = 1, \dots \dots , n \; j = 1, \dots \dots , m \tag{24}$$

Here $\tau^{+} = \begin{cases} 1 \; if \; AS_j < w_j x \alpha_{ij} \\ 0 \; if \; AS_j > w_j x \alpha_{ij} \end{cases}$

$$dE\left(AS_j\right)_i^{-} = \sqrt{\sum_{j=1}^{m} \tau^{-} \left(AS_j - w_j x \alpha_{ij}\right)^2} \, , i = 1, \dots \dots , n \; j = 1, \dots \dots , m \tag{25}$$

$$dT(AS_j)_i^- = \sum_{j=1}^{m} \tau^- |AS_J - w_j x \alpha_{ij}|, i = 1, \dots \dots, n \; j = 1, \dots \dots, m \quad (26)$$

Here $\tau^- = \begin{cases} 1 \; if \; AS_j > w_j x \alpha_{ij} \\ 0 \; if \; AS_j < w_j x \alpha_{ij} \end{cases}$

Adım 6: the alternatives are ranked based on their comprehensive distance (dC_i) which is calculated using Eq. (27).

$$dC_i = \frac{d(PIS_j) - d(NIS_j) - d(AS_j)_i^+ + d(AS_j)_i^-}{4}, i = 1, \dots \dots, n \quad (27)$$

The best alternative will be determined by selecting the option with the smallest value of dC_i.

4. Case Study

The study proposes a hybrid decision model, comprising SWARA, MEREC, and COBRA methods, to evaluate the sustainability performance of Anadolu Insurance Company. The SWARA and MEREC methods were used to determine the importance weights of the criteria, while the COBRA method was used to rank Anadolu Insurance Company's sustainability performance over the years. This section presents the analysis results obtained from the methods used in the proposed hybrid model, following an explanation of the introductory information about the dataset and alternatives used in the analysis.

4.1 Data

In recent years, many insurance companies in Turkey have begun publishing annual sustainability reports as part of their participation in the sustainable development process. This study focuses on Anadolu Insurance Company, which was established as Turkey's first national insurance company. Anadolu Insurance Company is one of the pioneers in the sector in terms of premium volume and share of the market. Since 2018, the company has been publishing a sustainability report regularly. The analysis included Anadolu Sigorta Company's data from 2018-2022, compiled from their annual sustainability reports. Fig. 2 presents the criteria used to evaluate sustainability performance.

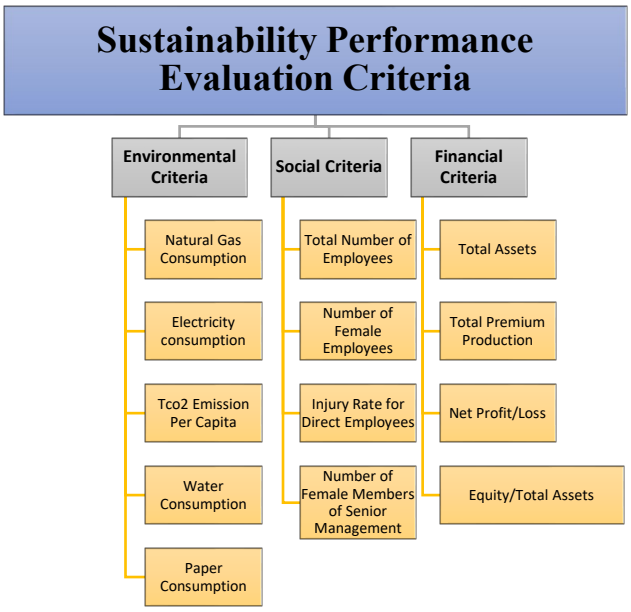

Fig. 2. Sustainability Performance Evaluation Criteria

The primary evaluation criteria for sustainability performance are environmental criteria (C1), social criteria (C2) and financial criteria (C3). The sub-criteria used to evaluate sustainability performance are as follows: Natural Gas Consumption (C11), Electricity Consumption (C12), TCO2 Emission per Capita (C13), Water Consumption (C14), Total Paper Consumption (C15), Total Number of Employees (C21), Female Employees. The remaining criteria are as follows: Number of Women (C22), Injury Rate (C23), Number of Female Members of Senior Management (C24), Total Assets (C31), Total Premium Production (C32), Net Profit/Loss (C33) and Equity/Total Assets (C34). The 2018-2022 period, which constitutes the alternatives of the study, is coded as 2018(A1), 2019(A2), 2020(A3), 2021(A4) and 2022(A5). The benefit-oriented criteria, C21, C22, C24, C31, C32, C33 and C34, contrast with the cost-oriented criteria, which include all other criteria.

4.2 Results Obtained from SWARA Algorithm

In order to determine the relative importance of the sustainability performance evaluation criteria shown in Figure 2, the opinions of one insurance industry representative and two academic experts were utilised. Firstly, as stated in the first two steps of the SWARA method, the criteria were ranked separately by each decision maker (DM) expert from the most

important to the least important, and their relative importance levels (S_J) were determined. The relevant results for the main criteria are presented in Table 2.

Tablo 2
Importance Ranks and Relative Importance Levels of Main Criteria According to Decision Makers

DM1		DM2		DM3	
Criteria/Importance Ranking	S_J	**Criteria/Importance Ranking**	S_J	**Criteria/Importance Ranking**	S_J
C1/1		**C1**/1		**C2**/1	
C2/2	0.30	**C2**/2	0.40	**C1**/2	0.20
C3/3	0.15	**C3**/3	0.20	**C3**/3	0.50

Once the relative importance levels of the criteria had been determined, the importance weights of the criteria were calculated separately for each decision maker using Equations (1)-(3). A sample calculation for decision maker 1 is shown in Table 3.

Table 3
Relative Weights of Main Criteria for Decision Maker-1

Decision Maker-1					
Importance Ranking	**Criteria**	S_J	k_j	q_j	w_j
1	C1		1	1.000	0.410
2	C2	0.30	1.30	0.769	0.274
3	C3	0.15	1.15	0.669	0.316

Table 3 presents the relative weights of the primary criteria for decision-maker 1, as determined by the SWARA method. Table 3 indicates that the order of importance of the primary criteria is C1 (Environmental Criteria) > C3 (Financial Criteria) > C2 (Social Criteria).

The calculations shown in Table 3, which serve as an illustrative example for decision maker-1, were repeated for the other two decision makers. The final importance weights of the main criteria were calculated by taking the geometric mean of the criterion importance weights obtained for each decision maker. The relevant results are reported in Table 4.

Table 4
Combined Final Overall Weights of Main Criteria

Kriter	**DM1**	**DM2**	**DM3**	**Final weight**
C1	0.410	0.433	0.349	0.396
C2	0.274	0.258	0.419	0.309
C3	0.316	0.309	0.233	0.283

Table 4 presents the relative importance of the main criteria for all decision makers, with the final weights of the criteria obtained by taking the geometric mean of the criterion weights of three decision makers. The results in Table 4 indicate that environmental criteria have the highest importance among the main criteria, followed by social and financial criteria, respectively. Subcriteria were ranked in order of importance by each decision maker, and their relative importance levels (S_J) were determined. The relevant results for the subcriteria are presented in Table 5.

Table 5
Importance Ranks and Relative Importance Levels of Sub-Criteria According to Decision Makers

Environmental Criteria						
	DM1		**DM2**		**DM3**	
Importance Ranking	**Criteria**	S_J	**Criteria**	S_J	**Criteria**	S_J
1	**C13**		**C13**		**C13**	
2	**C14**	0.15	**C15**	0.10	**C14**	0.30
3	**C15**	0.25	**C14**	0.20	**C15**	0.15
4	**C12**	0.30	**C12**	0.15	**C11**	0.10
5	**C11**	0.10	**C11**	0.10	**C12**	0.10
Social Criteria						
	DM1		**DM2**		**DM3**	
Importance Ranking	**Criteria**	S_J	**Criteria**	S_J	**Criteria**	S_J
1	**C22**		**C24**		**C24**	
2	**C24**	0.10	**C22**	0.15	**C22**	0.10
3	**C23**	0.10	**C21**	0.25	**C23**	0.05
4	**C21**	0.20	**C23**	0.15	**C21**	0.15
Financial Criteria						
	DM1		**DM2**		**DM3**	
Importance Ranking	**Criteria**	S_J	**Criteria**	S_J	**Criteria**	S_J
1	**C33**		**C34**		**C33**	
2	**C34**	0.40	**C33**	0.20	**C34**	0.20
3	**C31**	0.10	**C31**	0.40	**C31**	0.05
4	**C32**	0.30	**C32**	0.20	**C32**	0.30

The calculations presented in Table 3 were applied to all sub-criteria for all decision makers, and the final weights were obtained by taking the geometric mean of the importance weights of the sub-criteria determined for all decision makers. The relevant results are reported in Table 6.

Table 6
The Aggregate Final Local Weights of The Subcriteria

Environmental			Social			Financial		
Criteria	W_j	**Rank**	**Criteria**	W_j	**Rank**	**Criteria**	W_j	**Rank**
C11	0.152	5	**C21**	0.211	4	**C31**	0,225	3
C12	0.157	4	**C22**	0.274	2	**C32**	0,177	4
C13	0.270	1	**C23**	0.224	3	**C33**	0,313	1
C14	0.206	3	**C24**	0.287	1	**C34**	0,280	2
C15	0.213	2						

The global weights for all sub-criteria were calculated by multiplying the weights of the main criteria and the weights of the sub-criteria. The global weights of the sub-criteria are presented in Table 7.

Table 7
Global Weights for All Criteria

Main Criteria	Sub-criteria	Global Weights	Rank
C1(0.396)	**C11**(0.152)	0.060	12
	C12(0.157)	0.062	11
	C13(0.270)	0.107	1
	C14(0.206)	0.081	6
	C15(0.213)	0.084	5
C2(0.309)	**C21**(0.211)	0.065	9
	C22(0.274)	0.085	4
	C23(0.224)	0.069	8
	C24(0.287)	0.089	2
C3(0.283)	**C31**(0.225)	0.064	10
	C32(0.177)	0.050	13
	C33(0.313)	0.089	3
	C34(0.280)	0.079	7

Upon examination of the results obtained with the SWARA method, it was determined that the three most effective criteria in determining the sustainability performance of Anadolu Sigorta Company were the C13, C24 and C33 criteria, respectively. Conversely, the three most ineffective criteria were determined to be C32, C11 and C12.

4.3 Results Obtained from MEREC Algorithm

The decision matrix, which comprises Anadolu Sigorta Company's five-year data for the period 2018-2022, is presented in Table 8.

Table 8
Decision Matrix

	C11	C12	C13	C14	C15	C21	C22	C23	C24	C31	C32	C33	C34
A1	479	10.215	1.65	13.511	28.010	1.288	666	0.97	1	7.904.032	5.701.355	307.574	0.21
A2	783	10.321	1.61	14.694	7.180	1.334	696	0.64	1	9.767.228	6.606.856	403.062	0.22
A3	421	8.334	1.18	11.133	2.430	1.382	704	0.12	1	16.775.578	8.015.704	403.062	0.23
A4	117	8.832	1.17	4.967	3.000	1.491	761	0.07	1	12.075.878	10.735.252	521.837	0.19
A5	382	8.979	1.01	4.895	6.330	1.652	838	0.32	1	30.706.036	23.755.830	1.133.201	0.2

The values in the decision matrix are normalised by Eq. (5). The normalised decision matrix is presented in Table 9.

Table 9
Normalised Decision Matrix

	C11	C12	C13	C14	C15	C21	C22	C23	C24	C31	C32	C33	C34
A1	0.612	0.990	1.000	0.919	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.905
A2	1.000	1.000	0.976	1.000	0.256	0.966	0.957	0.660	1.000	0.809	0.863	0.763	0.864
A3	0.538	0.807	0.715	0.758	0.087	0.932	0.946	0.124	1.000	0.471	0.711	0.763	0.826
A4	0.149	0.856	0.709	0.338	0.107	0.864	0.875	0.072	1.000	0.655	0.531	0.589	1.000
A5	0.488	0.870	0.612	0.333	0.226	0.780	0.795	0.330	1.000	0.257	0.240	0.271	0.950

The overall performance value (S_i) for each alternative was calculated using Eq. (6). The resulting values were 0.037, 0.087, 0.036, 0.111, and 0.050, respectively. Once the S_i values had been determined, each criterion was removed separately from the criterion set and the S'_{ij} values for each alternative were calculated using Eq. (7). The matrix of S'_{ij} values for all the alternatives is shown in Table 10.

Table 10
S'_{ij} Values

	C11	C12	C13	C14	C15	C21	C22	C23	C24	C31	C32	C33	C34
A1	0.000	0.036	0.037	0.030	0.037	0.037	0.037	0.037	0.040	0.040	0.040	0.039	0.007
A2	0.087	0.087	0.089	0.087	0.010	0.085	0.084	0.090	0.094	0.082	0.087	0.096	0.087
A3	0.011	0.020	0.011	0.015	0.002	0.041	0.040	0.047	0.039	0.044	0.024	0.012	0.045
A4	0.029	0.100	0.087	0.135	0.106	0.100	0.101	0.095	0.119	0.105	0.105	0.099	0.044
A5	0.004	0.039	0.042	0.004	0.026	0.045	0.044	0.051	0.054	0.036	0.041	0.037	0.020

The effect of the removal of each criterion (E_j) on the overall performance of the alternatives was calculated using Eq. (8), with the assistance of the S_i ve S'_{ij} The objective criterion weights (W_j) for each criterion were then determined using Eq. (9). Table 11 contains the relevant values.

Table 11
E_j Values and Criteria Weights (W_j)

	C11	C12	C13	C14	C15	C21	C22	C23	C24	C31	C32	C33	C34
E_j	0.188	0.038	0.058	0.098	0.140	0.022	0.022	0.032	0.026	0.036	0.030	0.058	0.135
W_j	0.213	0.043	0.066	0.111	0.158	0.025	0.025	0.036	0.029	0.041	0.034	0.066	0.153

According to the MEREC method results given in Table 11, the criteria are C11>C15>C34>C14>C33>C13>C12>C31>C23>C32>C24>C22>C21 according to their importance weights.

4.4 Combined Weighting Algorithm Results

The criterion weights obtained through the application of the SWARA and MEREC procedures were combined with a combination operator based on the weighted average, as outlined in Eq. (10). The resulting combined criterion weights are presented in Table 12.

Table 12
Combined Criteria Weights

	C11	C12	C13	C14	C15	C21	C22	C23	C24	C31	C32	C33	C34
W_j	0.168	0.035	0.093	0.119	0.175	0.022	0.028	0.033	0.034	0.034	0.022	0.077	0.160

The results of the common weighting algorithm are presented in Table 12. The order of importance of the criteria is as follows:

C15>C11>C34>C14>C13>C33>C12>C31>C24>C23>C22>C32>C22 the results of the ranking indicate that the criterion with the greatest impact on the sustainability performance of Anadolu Sigorta Company is Total Paper Consumption, while the criterion with the least impact is Number of Female Employees.

4.5 Results Obtained from COBRA Algorithm

The elements of the decision matrix displayed in Table 8 were normalised utilising Eq. (12), resulting in the weighted normalised decision matrix. This was obtained by applying the criterion weights derived through the common weighting procedure in Eq. (13). The positive ideal, negative ideal and average solutions were calculated using Eqs. (14-16). The weighted normalised matrix and PIS_j NIS_j and AS_j values are presented in Table 13.

Table 13
Weighted Normalised Matrix

	C11	C12	C13	C14	C15	C21	C22	C23	C24	C31	C32	C33	C34
A1	0.103	0.035	0.093	0.109	0.175	0.017	0.023	0.033	0.034	0.009	0.005	0.021	0.146
A2	0.168	0.035	0.090	0.119	0.045	0.018	0.024	0.022	0.034	0.011	0.006	0.027	0.153
A3	0.090	0.028	0.066	0.090	0.015	0.018	0.024	0.004	0.034	0.019	0.007	0.027	0.160
A4	0.025	0.030	0.066	0.040	0.019	0.020	0.026	0.002	0.034	0.013	0.010	0.035	0.132
A5	0.082	0.030	0.057	0.040	0.040	0.022	0.028	0.011	0.034	0.034	0.022	0.077	0.139
PIS_j	0.025	0.028	0.057	0.040	0.015	0.022	0.028	0.002	0.034	0.034	0.022	0.077	0.160
NIS_j	0.168	0.035	0.093	0.119	0.175	0.017	0.023	0.033	0.034	0.009	0.005	0.021	0.132
AS_j	0.094	0.032	0.074	0.079	0.059	0.019	0.025	0.014	0.034	0.017	0.010	0.038	0.146

Euclidean and taxicab distances from the positive, negative and average solutions were calculated using Eqs (17-26). The calculated values in Eq. (27) were then used to rank the alternatives according to their comprehensive distances. The relevant results are reported in Table 14.

According to the COBRA method results reported in Table 14, Anadolu Sigorta Company's sustainability performance ranking for the 2018-2022 period is A5 (2022) > A4 (2021) > A3 (2020) > A2 (2019) > A1 (2018).

Table 14
Results of the COBRA Method

	$d(PIS)$	$d(NIS)$	$d(AS^{+})$	$d(AS^{-})$	dC	Rank
A1	0.223	0.068	0.128	0.020	0.012	5
A2	0.192	0.137	0.089	0.019	-0.004	4
A3	0.102	0.199	0.018	0.048	-0.017	3
A4	0.058	0.248	0.001	0.094	-0.025	2
A5	0.067	0.210	0.045	0.050	-0.035	1

4.6 Comparison Analysis with Alternative Decision Algorithms

In order to determine the stability of the ranking results obtained by applying the proposed model, a comparison analysis was made with MCDM methods based on different ranking algorithms. In order to determine the best alternative, a similar ranking comparison was made with frequently preferred methods such as MOOSRA, WASPAS, PIV and TOPSIS to reveal the reliability of the proposed SWARA-MEREC-COBRA model. The resulting ranking results are shown in Fig. 3.

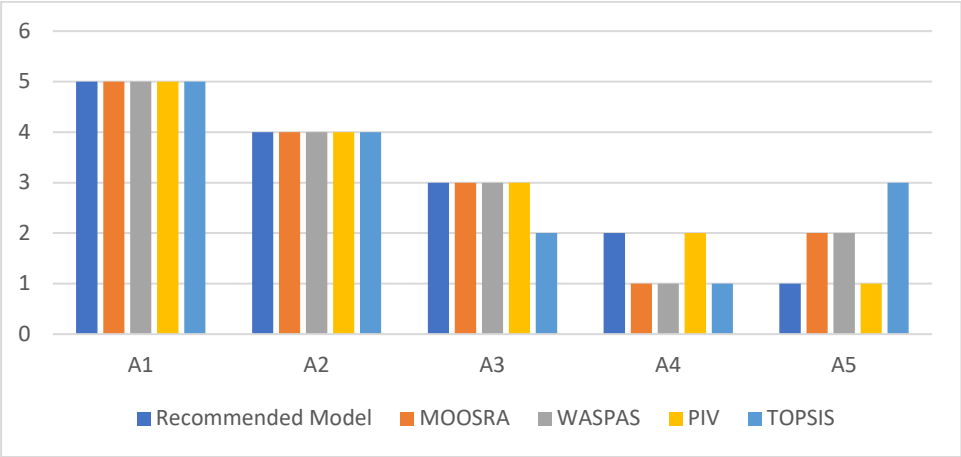

Fig. 3. Ranking Results of Different Decision Algorithms

The results presented in Figure 3 demonstrate a high positive correlation between the ranking results of all applied MCDM algorithms. It can be observed that there are minor differences between the proposed model results and only the PIV and TOPSIS method results. The average correlation between the proposed model results and all other method results was determined to be 87%. These results substantiate the assertion that the proposed model is a highly stable and robust technique.

4.7 Sensitivity Analysis Based on Different Criteria Weighting Scenarios

A total of 100 distinct scenarios were devised to assess the influence of alterations in the relative importance of the criteria on the final rankings of the decision alternatives. In each scenario, the importance weight of a given evaluation criterion was reduced by 10%, with the resulting reduction being added proportionately to the other criteria. The sum of the weight values was then calculated as 1. Fig. 4 illustrates the resulting rankings for the alternatives in the new scenarios.

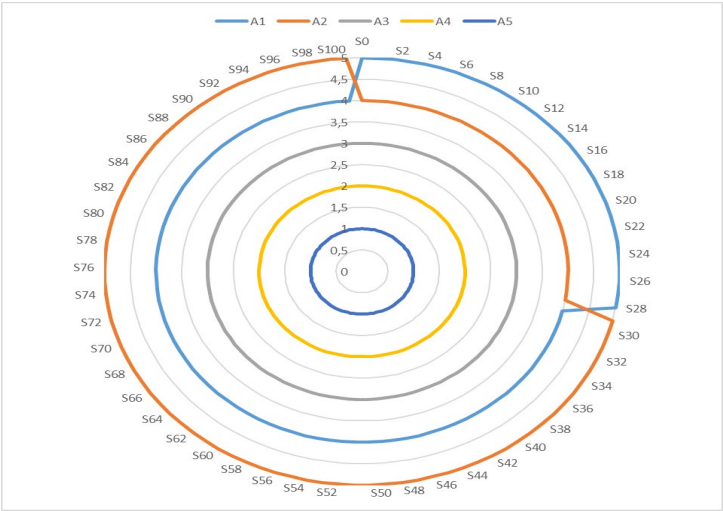

Fig. 4. Sensitivity Analysis of Alternatives Using 100 Scenarios

The results presented in Figure 4 demonstrate that the distinct weight values attributed to the criteria in accordance with the novel scenarios have led to alterations in the ranking of certain alternatives. It can be observed that the proposed model is susceptible to fluctuations in the weight coefficients. Upon examination of the results based on varying criterion weights, it was established that the A3, A4 and A5 alternatives retained their positions in the rankings across all scenarios. Conversely, the positions of the A1 and A2 alternatives in the rankings exhibited discrepancies in the new scenarios. While the A1 alternative was ranked fifth in the initial 28 scenarios, it was ranked fourth in the subsequent scenarios. Conversely, the A2 alternative was ranked fourth in the initial 28 scenarios and fifth in the subsequent scenarios. Consequently, it was observed that there were minor changes in the ranking results that did not affect the overall results. This confirms that the proposed decision model provides stable and consistent results.

4.8 Sensitivity Analysis Based on the Rank Reversal Problem

Deleting an alternative from the decision matrix or adding a new alternative to the decision matrix may create differences in the ranking results (Stevic et al., 2020: 9). For this reason, different scenarios created by changing the decision matrix elements were designed in order to test the consistency of the results of the model proposed in the study. A1, which was determined as the worst alternative in the first setup, was removed from the decision matrix. Following this, according to the ranking results determined in the subsequent scenarios, the worst alternatives were respectively removed from the decision matrix and the previous removed alternative was added again. The results obtained are presented in Fig. 5.

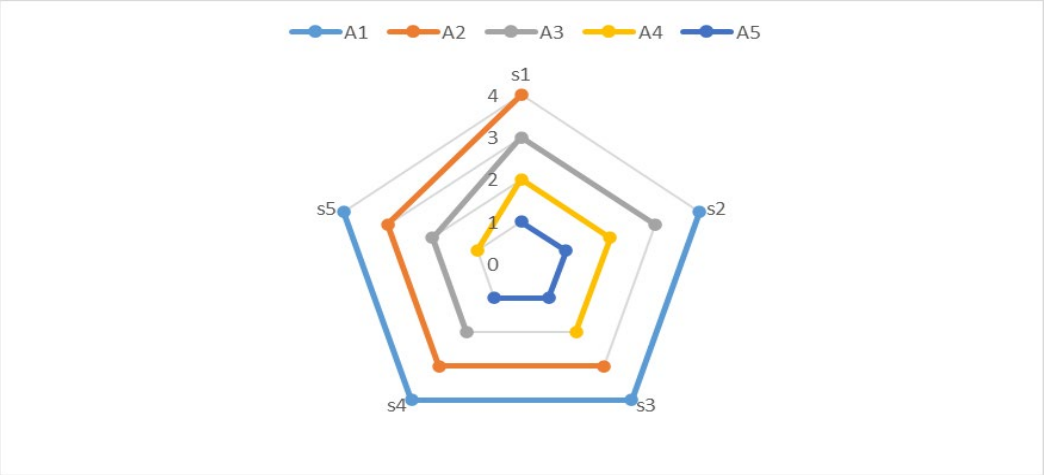

Fig. 5. Sensitivity Analysis Based on Alternative Inference

When the sensitivity analysis results presented in Fig. 5 are examined, it is seen that the lines of different scenarios do not intersect each other. The results confirm the consistency and robustness of the proposed model.

In the scenarios created in the second setup, the alternatives were added to the decision matrix one by one, starting from alternative A1, and ranked by comparing them with each other. The results obtained are reported in Fig. 6.

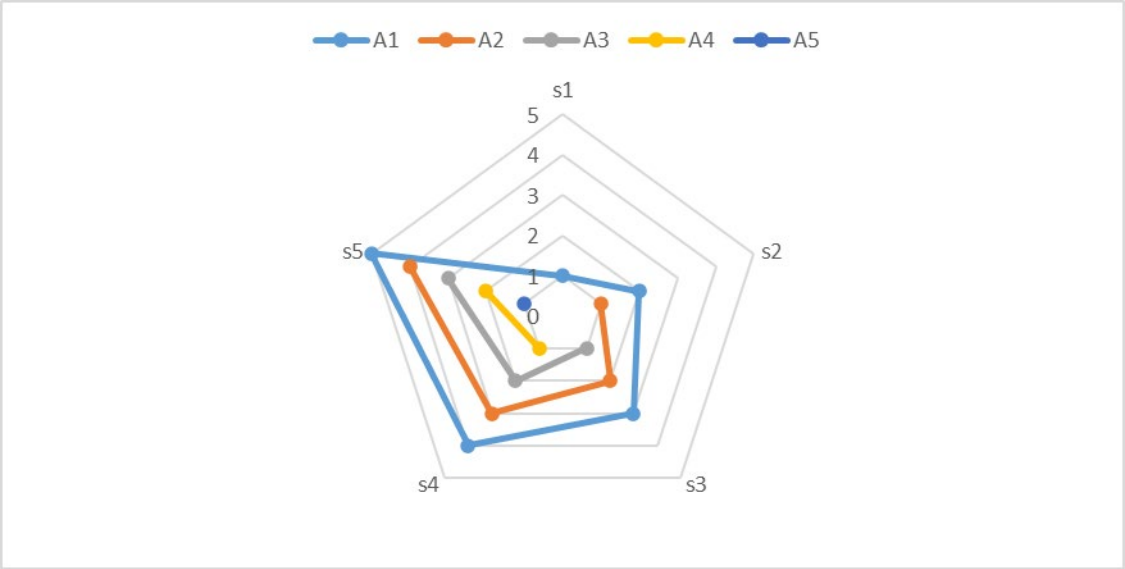

Fig. 6. Sensitivity Analysis Based on Alternative Addition

In the sensitivity analysis results reported in Fig. 6, it is seen that none of the lines belonging to the different scenarios intersect. These results support the stability and consistency of the proposed model.

9. Conclusion

In recent times, the growing awareness of the role sustainability plays in economic development has led businesses to prioritize corporate sustainability as a key goal and agenda item. This is not limited to production sectors but extends to all sectors. One such sector is the insurance sector, which forms a vital part of country financial systems. Insurance companies fulfil a number of social and economic functions, including the minimisation of the impact of financial losses that may occur as a result of various events, the reduction of uncertainty and fear, the creation of financial resources and the creation of new business opportunities. Consequently, the performance of the insurance industry has a significant impact on the growth of other industries and the country's economy. There is a direct relationship between economic development and social, human and environmental development. It is therefore evident that the insurance sector, which plays a pivotal role in the country's economy, also exerts an influence on sustainable development. Insurance companies engage in sustainability activities and facilitate the implementation of sustainability in other sectors.

The objective of this study is to assess the sustainability performance of the insurance industry based on environmental, social and economic indicators. To this end, a hybrid decision model comprising SWARA, MEREC and COBRA algorithms has been proposed. In order to ascertain the consistency and validity of the proposed model, the sustainability performance of Anadolu Sigorta Company has been used as a case study. In contrast to numerous studies in the literature, the present study evaluates the performance of the insurance sector not only based on financial indicators but also with environmental and social indicators. Furthermore, the results obtained with the proposed model were subjected to different sensitivity analyses, and the results were found to be valid and reliable.

In accordance with the proposed model, the relative importance of the evaluation criteria used to assess the sustainability performance of the insurance company was initially determined through the application of the SWARA and MEREC algorithms, from both a subjective and objective perspective. Subsequently, the subjective and objective results were integrated to yield the final importance weights of the criteria. Upon examination of the results obtained with the common weighting algorithm, it was determined that the most important criterion in determining the sustainability performance of Anadolu Sigorta Company for the analysed period was the total paper consumption criterion. However, the most ineffective criterion on sustainability performance was determined to be the number of female employees.

Upon examination of the results provided by the COBRA ranking algorithm, it was determined that Anadolu Sigorta Company exhibited a consistent and notable improvement in its sustainability performance between the 2018-2022 period. The company's performance reached its peak in 2022, indicating that the company's sustainability policies were effectively implemented. A review of the company's sustainability reports indicates that there will be an increase in electricity consumption of 12%, natural gas consumption of 20%, water consumption of 63% and paper consumption of 77% in 2022 compared to 2018. Additionally, the company's female employee ratio is 50% and the female manager ratio is 47% in 2022. Nevertheless, it is evident that the company, which generated a revenue of 5.7 billion TL in 2018, will reach 23.8 billion TL by 2022. Furthermore, the company, which recorded a net profit of 307.6 million TL in 2018, will have a net profit of 1.13 billion TL in 2022. These developments can be considered to have an impact on the continuous increase in the company's sustainability performance during the 2018-2022 period.

This study makes a novel contribution to the existing literature on insurance sector sustainability performance evaluation. Unlike previous studies, it does not focus solely on financial performance indicators, but also incorporates environmental and social indicators. Furthermore, the proposed performance evaluation model can be applied to performance analyses based on different indicators in different sectors.

The findings of the study may provide guidance on the environmental, social and financial issues that company managers should consider in their future strategic decisions regarding sustainable development, which has become a significant concern in recent times. It is thought that the study findings may influence the future choices of company customers and employees. Furthermore, it can serve as a resource for the sustainability activities of the supervisory and regulatory authorities of the sector.

The limitation of the study is that only one company is analysed within the scope of the study. In future studies, more general results for the sector can be obtained by extending the data period and including different companies in the analysis.

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