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A Hybrid Multidimensional Performance Measurement Model Using the MSD-MPSI-RAWEC Model for Turkish Banks *

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Abstract

The purpose of the paper is to analyze the multidimensional sustainability performance of deposit banks that operate in the Turkish banking industry. For this aim, the current research presents a novel hybrid decision-making model comprising of MSD, MPSI and RAWEC methodologies. In the developed decision-making model, the MSD and the MPSI objective weighting methods are utilized to assign significance weights to the criteria, while the RAWEC, a relatively new technique, is employed for banks' ranking. In order to check the robustness of the recommended model, various sensitivity and benchmark analyses were conducted. According to the findings of the study, the most important criterion in determining the sustainability performance of deposit banks is the total hours spent on employee training. Moreover, the most successful bank in terms of multidimensional sustainability is Garanti BBVA. Furthermore, sensitivity and comparison analyses prove that the integrated framework in this study is a powerful, reliable and useful decision tool that can be utilized in assessing the sustainability performance of banks. Besides, practical and managerial implications based on the findings of the applied decision-making tool are discussed.

Keywords: ***Banks, Sustainability Performance, MSD, MPSI, RAWEC.***

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1. INTRODUCTION

Banks play a critical role as financial intermediaries not only in developed economic systems but also in developing economic systems. They are responsible for almost all transactions in money and capital markets, regardless of whether the financial system is market-oriented or bank-oriented (Shabir et al., 2021; Zahid et al., 2021, Işık et al., 2024). Driven by the desire to make profit, banks play an essential role in fulfilling the financing needs of the real sector by channeling the savings in the financial system to investments (Işık, 2017; Bucevska and Hadzi Misheva, 2017). The banking sector is vital for the economic and sustainable development of countries (Love and Rachinsk, 2015; Işık and Belke, 2017; Zhou et al., 2021). Its role extends beyond providing financial stability to the economy. A strong macro-level infrastructure and a healthy banking sector are crucial for sustainable prosperity, particularly in times of systematic and unsystematic risks, such as credit risk (Wu and Shen, 2013). It is, therefore, crucial to continuously analyze the performance of banks to ensure they can emerge from any crisis with minimal impact. Any necessary regulations and improvements should be implemented to establish a solid foundation for banking operations based on empirical findings (Amile et al., 2013; Munteanu, 2012).

Performance assessment is a highly important topic for internal and external stakeholders in the banking industry. The primary aim of performance measurements is to identify the effective use of available resources. Given the prior works in the literature aimed at gauging the performance of the banking sector, it is seen that most of these studies were carried out solely depending on financial indicators. However, this situation causes banks to be assessed from a single dimension, or in other words, only from a financial perspective (McGuire et al., 1988; Ullmann, 1985). In today's global financial markets, evaluating bank performance in a single dimension can be misleading. Because, besides financial factors, there are also environmental factors that influence bank performance (Ren et al. 2023). Data on environmental, social and governance issues obtained from sustainability reports published by banks enable the evaluation of the performance of banks not only in financial terms but also based on non-financial ESG indicators (Ielasi et al., 2023; Meng-tao et al., 2023; Shabir et al., 2024a; Işık, 2023). This evaluation process goes beyond financial performance and enables a more holistic perspective on performance (Gaur et al., 2011). Besides, as one of the most efficient institutions in the financial intermediation process, any deterioration in the performance of banks can have significant economic consequences for companies, individuals, and governments. It is therefore crucial to systematically analyse the sustainability of banks' performance in order to promote sustainable economic development (Shabir et al., 2024b). Moreover, the COVID-19 pandemic and the recent political and financial crises have revealed the need to regularly measure and evaluate banks' multi-dimensional performance (Xiazi and Shabir, 2022; Shabir et al., 2023).

The present research aims to examine the banks' sustainability performance according to a novel set of criteria covering four main dimensions, such as financial, environmental, social, and corporate governance. To that end, a novel combined decision-making framework is presented in the existing work, which includes Modified Standard Deviation Method (MSD), Modified Preference Selection Index (MPSI) and Ranking of Alternatives by Criterion Weights (RAWEC) techniques. Overall, with the aid of the presented hybrid framework, the present research aims to respond to the given research questions below.

RQ1. Why is it important to compare the performance of banks in terms of multidimensional performance?

RQ2. Which criteria should be considered for multidimensional performance assessment in the banking industry?

RQ3. What is the most significant variable affecting multidimensional performance in the banking industry?

RQ4. Which bank in the Turkish commercial banking industry is more successful than its competitors in terms of multidimensional performance?

With the aid of research questions that address gaps in the prior literature, bank executives and other decision makers in the banking industry can identify a practical and trustworthy methodological approach to analyzing in detail the multidimensional sustainability performance of banks. The novelty and contributions of the recommended decision-making tool can be summarized as follows:

- The existing work presents a methodological framework and decision support system for addressing multidimensional performance measurement problems for decision makers in the field of banking.
- The outcomes obtained from the procedures using MSD and MPSI are integrated via an aggregation operator to compute the optimal weights of the criteria. The weighting strategy pursued in existing work is utilized for the first time in the MCDM literature.
- The RAWEC algorithm, which is a relatively novel ranking procedure, is implemented for the first time in the MCDM literature.
- To investigate banks' multidimensional performance, a case study has been carried out that considers 21 performance metrics derived from a combination of the CAMELS rating system and ESG practices. The current work is also the first to examine the multidimensional performance of banks through an integrated decision framework.
- Managerial implications for industry-linked decision-makers are provided to improve the multidimensional performance of the banking industry and build a sustainable banking system.
- In order to test the validity of the suggested decision-making model, a thorough sensitivity and benchmarking study has been carried out.

The following sections are organized as follows: Section two provides a comprehensive literature review and explains how the study will fill gaps in the literature. The paper discusses the suggested MCDM tools from a theoretical perspective in the third section. The case study is presented in section four, followed by the outcomes of the suggested framework for multidimensional performance assessment for banks in section five. Section six presents sensitivity analyzes and related validation analyses, while section seven discusses practical and managerial implications. The final section summarizes the achieved outcomes and provides recommendations for future work.

2. RESEARCH BACKGROUND

This section is divided into two subsections. In the first subsection, background information is given by summarizing banking studies using MCDM models. In the second subsection, research gaps that form the basis for the purpose and motivation of the current study are presented.

2.1. MCDM Studies in the Banking Industry

Since banks are an indispensable part of a sustainable economic system, the number of studies gauging bank performance from different aspects employing MCDM approaches continues to increase rapidly. A brief summary of some studies in the existing literature is presented below to provide background information.

Havrylchyk (2006) used the DEA method to analyze the efficiency of the Polish banking system from 1997 to 2001. The study found that foreign-capitalized banks were more successful than nationally capitalized banks. Seçme et al. (2009) evaluated the performance of five banks in Turkey using the Fuzzy AHP and TOPSIS methods. The analysis revealed that Ziraat Bank had the best performance in 2007, while Yapı Kredi Bank had the worst performance. Gishkori and Ullah (2013) evaluated the efficiency levels of banks in Pakistan with various ownership structures using DEA and Tobit Regression methods from 2007 to 2011. The study performed that 5 banks achieved the targeted efficiency levels in 2007, 8 banks in 2008, 20 banks in 2009, 27 banks in 2010, and 23 banks in 2011. Moreover, based on Tobit regression analysis, bank-level indicators are crucial in determining technical efficiency levels. In a separate study, Doğan (2013) compared the performance of 10 banks listed on the BIST using the Gray Relational Analysis method. The analysis, which covered the period from 2005 to 2011, concluded that Akbank had the most successful performance during that time. Mandic et al. (2014) assessed the performance of commercial banks in Serbia employing Fuzzy AHP and TOPSIS methods. The assessments for the period 2005-2010 showed that Banca Intesa was the most successful bank, while Moskovska Bank was the least successful. Yamaltdinova (2017) analyzed the performance of 15 Kyrgyz deposit banks for the period 2010-2014 employing expert opinion and TOPSIS methods. The methods used showed that Demir Kyrgyz International Bank performed the best during the relevant periods. In a separate study of 8 banks listed on the Malaysian Stock Exchange from 2011-2015, Siew et al. (2017) utilized the equal weight and TOPSIS model and found that CIMB Group Holdings Berhad was the most successful bank during the analyzed periods. Wanke et al. (2018) analyzed the performance of banks operating in BRICS countries employing Fuzzy TOPSIS and Bootstrap Regression models. The study, conducted for the 2010-2014 period, revealed a positive relationship between the efficiency level of the banking system and the savings and GINI index in the country. Laha and Biswas (2019) suggested the Entropy and CODAS integrated model in their study, using a sample of 5 public and 5 private banks in India for the period 2012-2016. The study found that privately owned banks outperformed publicly owned banks. Işık (2020) analyzed the performance of three state-owned development and investment banks in Turkey from 2014 to 2018 employing a hybrid tool consisting of SD, MABAC and WASPAS methods. The author's outcomes demonstrate that Turk Eximbank was the most successful during this period. Sama et al. (2020) evaluated the performance of 18 private sector banks in India from 2018 to 2019 using CRITIC-TOPSIS and CRITIC-GIA methods. After applying the selected analysis methods, HDFC Bank ranked first, and Bandhan Bank ranked second. The rankings of other banks were found to vary. Furthermore, Gazel et al. (2021) examined the performance of deposit banks in Turkey utilizing an integrated model consisting of Fuzzy Entropy, Fuzzy TOPSIS and Regression methods to determine the criteria. Adabank, Deutsche Bank and Citibank were the top-performing banks from 2007-2017. In 2020, Rao et al. analyzed the performance of six privately owned Indian banks with the help of SD, CRITIC, ARAS and MOORA methods. The analysis revealed that HDFC had the highest performance, while Yes Bank had the lowest. The study used MEREC, PSI, and MAIRCA methods. Işık (2022) conducted a study on the performance of the Turkish participation banking sector from 2019Q1 to 2020Q4. It was reported that the sector's most successful period was December 2020, while the least successful period was March 2019. Milenković et al. (2022) ranked banks in the Western Balkan states according to their efficiency levels using the fuzzy DEA method in a sample of banks. The study conducted between 2015 and 2019 found that efficiency levels varied both between and within countries over the years. Avşarlıgil et al. (2023) employed Entropy, ARAS, MOORA and MOOSRA methods to evaluate the performance of 13 commercial banks in Turkey for the period 2019-2020. The study concluded that Ziraat Bank was the most successful bank, while Halkbank consistently ranked among the top 5 most successful banks. Kumar and Sharma (2023) evaluated the performance of ten large commercial banks in India from 2016-2017 to 2020-2021 via AHP and TOPSIS techniques. They found that return on equity had the highest impact on bank performance. Bandhan Bank was ranked as the best performing bank. The performance of 39 commercial banks operating in China between 2010 and 2018 was evaluated using DEA and SSRP algorithms. Productivity levels were found to gradually increase between 2010 and 2015, while fluctuating in other periods. Ali et al. (2024) analyzed the performance of 19 Iraqi banks between 2007 and 2020 using an integrated MCDM framework that consists of CRITIC and RAFSI techniques. The study measured financial sustainability performance and identified BTRI as the most successful bank and BNOR as the least successful. Kumar and Sharma (2024) evaluated the performance of the nine largest private sector banks in India with the aid of CRITIC and TOPSIS approaches. The analyses performed for the periods 2015-2016 and 2020-2021 determined that Bandhan Bank was the most successful bank throughout all periods.

2.2. Research Gap Analysis

The review of the previous literature shows that there are a large number of studies analyzing the performance of the banking sectors of different countries. However, most of these works are focused on financial performance analyses. Given today's competitive conditions, assessing bank overall performance only from a financial perspective may lead to a one-sided and non-objective assessment. To fill this gap in the literature, the current work introduces a set of criteria for analyzing multidimensional bank sustainability performance that includes both financial and non-financial performance indicators.

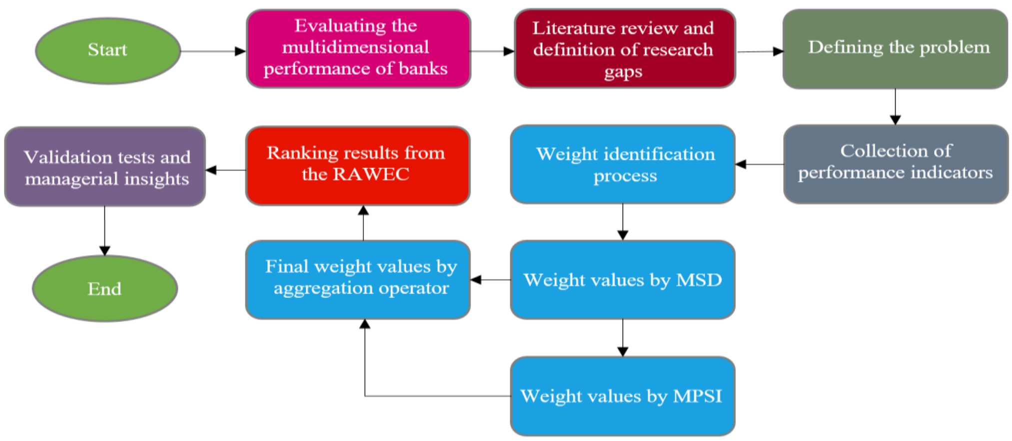
The second gap pertains to the lack of research in the literature that combines the MSD, the MPSI, and the RAWEC approach to gauge banks' sustainability performance. Thus, suggesting a performance measurement framework that integrates the beneficial aspects of the three approaches aims to fill the second research gap by providing a more holistic and practical evaluation of banks. Hence, the introduced decision-making tool has the potential to fulfill the need for a decision support system or methodological framework to accurately analyze the strengths and weaknesses of individual banks in comparison to others operating in the same industry.

The MSD-MPSI-RAWEC methodology formulated in this article assess and rank alternative banks and can help monitor and improve the multidimensional performance of banks in a competitive business environment.

3. METHODOLOGY

This section describes the recommended decision framework, i.e., the MSD-MPSI-RAWEC framework, for solving the multidimensional performance decision-making problem about the banking industry, as illustrated in Figure 1.

Figure 1. Proposed Approach



Note: Created by the author.

3.1. Modified Standard Deviation (MSD) Procedure

The MSD procedure developed by Puška et al. (2022) is an extension of the standard deviation (SD) technique. Unlike the SD approach, it includes two extra steps. The first step is to compute the sum of the column. The second step is to correct the value of the standard deviation based on this indicator. This procedure includes the following steps:

Step 1. The decision matrix (Y) is prepared as in Eq. (1). This matrix includes m alternatives, K1,…,Km based on the n criteria, D1,…, Dn.

$$Y = \left[y_{ij}\right]_{m\times n} \tag{1}$$

where y_{ij} indicates the assessment of the i-th alternative and the j-th criterion.

Step 2. This matrix is normalized based on Eq. (2) (for beneficial attributes) and Eq. (3) (for non-beneficial attributes).

$$v_{ij} = \frac{y_{ij}}{\max\{y_{ij} | i = 1,2, \ldots , m\}} \tag{2}$$

$$v_{ij} = \frac{\min\{y_{ij} | i = 1,2, \ldots , m\}}{y_{ij}} \tag{3}$$

Step 3. Calculating the standard deviation of each criterion (σ_n).

Step 4. Computing the sum of the sum of the columns.

Step 5. The corrected value of the standard deviation is calculated with the help of Eq. (4).

$$\sigma' = \frac{\sigma}{\sum_{j}^{n} y_{ij}} \tag{4}$$

Step 6. The final weights of the criteria are determined by applying Eq. (5).

$$w_J^{(MSD)} = \frac{\sigma_j'}{\sum_{j=1}^{n} \sigma_j'} \tag{5}$$

3.2. Modified PSI (MPSI) Procedure

The MPSI approach is a modified version of the Preference Selection Index (PSI) technique by developed by Maniya and Bhatt (2010). It is a flexible and easily applicable tool to address various MCDM issues (Gligorić et al., 2022). The method defines objective weights of the criteria and is characterized by its simplicity and understandability. The newly developed approach is effective in calculating weight coefficients and saves time in the process. For this reason, it is accepted and used as an effective method in weighting the criteria included in the decision process. This method consists of five sequential steps summarized below:

Step 1. A decision matrix (Y) is built. This matrix was demonstrated in Eq. (1).

Step 2. The normalized decision matrix is constructed as shown in Eq. (2) (for beneficial attributes) and Eq. (3) (for non-beneficial attributes).

Step 3. The mean values of the normalized decision matrix are found via Eq. (6):

$$\psi_j = \frac{1}{m}\sum_{i=1}^{m} v_{ij} \quad (6)$$

Step 4. Calculate the preference variation value ϑ_j as follows:

$$\vartheta_j = \sum_{i=1}^{m}(v_{ij} - \psi_j)^2 \quad (7)$$

Step 5. The weights of criteria are found with the help of following equation:

$$w_j^{(MPSI)} = \frac{\vartheta_j}{\sum_{j=1}^{n}\vartheta_j} \quad (8)$$

3.3. Combined Weights

The utilization of a variety of MCDM approaches in the estimation of criterion weight values leads to some differences in weight values. In order to overcome this problem, an aggregation operator is applied in this paper to compute the criterion weights efficiently while taking into account the influence of different MCDM methods at the same time (Işık et al., 2023). In the present manuscript, the criteria weights of MSD and MPSI are denoted as $w_j^{(MSD)}$ and $w_j^{(MPSI)}$, respectively, and the final weight of each criterion is computed from Eq. (9).

$$w_j = \psi w_j^{(MSD)} + (1-\psi) w_j^{(MPSI)} \quad (9)$$

3.4. RAWEC Method

The RAWEC method, one of the alternative ranking techniques in the field of MCDM, was recently introduced by Puška et al. (2024). Compared to many other MCDM approaches, this tool is simple, easy to implement, and effective. The procedure is based on double normalization and the calculation of deviations from ideal and anti-ideal values. This algorithm executes the following steps.

Step 1. A decision matrix (Y) is built. This matrix was demonstrated in Eq. (1).

Step 2. The normalized decision matrix is constructed by applying Eq. (10) (for beneficial attributes) and Eq. (11) (for non-beneficial attributes). Here, Double normalization, as shown in Eq. (11) and (12), is employed to normalize the decision matrix.

$$v_{ij} = \frac{y_{ij}}{\max\{y_{ij}|i = 1,2,\ldots,m\}} \text{ and } v'_{ij} = \frac{\min\{y_{ij}|i = 1,2,\ldots,m\}}{y_{ij}} \quad (10)$$

$$v_{ij} = \frac{\min\{y_{ij}|i = 1,2,\ldots,m\}}{y_{ij}} \text{ and } v'_{ij} = \frac{y_{ij}}{\max\{y_{ij}|i = 1,2,\ldots,m\}} \quad (11)$$

Step 3. Eq. (12) and (13) are applied to obtain the deviation from the criterion weight.

$$n_{ij} = \sum_{i=1}^{m} w_j \,.\, (1 - v_{ij}) \quad (12)$$

$$n'_{ij} = \sum_{i=1}^{m} w_j \,.\, (1 - v'_{ij}) \quad (13)$$

Here w_j indicates the final weight of criteria.

Step 4. The values of Ω_i are found for each alternative through Eq. (14).

$$\Omega_i = \frac{n'_{ij} - n_{ij}}{n'_{ij} + n_{ij}} \quad (14)$$

Based on the RAWEC procedure Ω_i takes values between -1 and 1. Here, the alternative with the highest Ω_i values are considered to be the best alternative.

4. A REAL CASE APPLICATION OF PERFORMANCE EVALUATION FOR BANKS

Multidimensional performance measurement in banking sectors is an intricate process that requires flexible and mathematical techniques due to the fact that it depends on many conflicting criteria. Furthermore, owing to the vital role that bankers play in creating a sustainable financial system via their financial services and investments, analyzing sustainability performance in the banking sector is quite critical. Therefore, this work aims to address the issue of sustainability performance measurement in the banking sector via a novel sustainability performance measurement model. In accordance with this purpose, a real-time case study is performed on Turkey's 6 leading commercial banks. The names of the alternative banks considered in this study and their market shares are shown in Table 1. Additionally, the key performance indicators considered as evaluation criteria are given in Tablo 2

Table 1. The Decision Alternatives

Code	Alternative	Market share (%)
A1	Akbank T.A.Ş.	0.0820
A2	Türkiye Garanti Bankası A.Ş.	0.0879
A3	Türkiye Halk Bankası A.Ş.	0.1061
A4	Şekerbank T.A.Ş.	0.0048
A5	Türkiye Vakıflar Bankası T.A.O.	0.1282
A6	Yapı ve Kredi Bankası A.Ş.	0.0845

Table 2. The Key Performance Indicators

Code	Definition	References
C1	Total Equity/Risk-Weighted Assets	Mili et al. (2017), Aras and Kazak (2022), Yıldırım and Yaman (2023)
C2	Total Loans / Total Assets	Zakaria and Purhanudin (2017), Zarafat and Prabhune (2018), Prabowo et al. (2018), Rawan (2019)
C3	Net Operating İncome/Total Assets	Hayajneh and Yassine (2011), Khalaf et al. (2015), Cui et al. (2023), Feng and Wu (2023)
C4	Net Profit/ Total Assets	Mili et al. (2017), Buallay et al. (2021), Ali et al. (2023)
C5	Liquid Assets / Short-Term Foreign Liabilities	Wang et al. (2020), Coetzee and Genukile (2020), Chatzitheodorou et al. (2021), Brei et al. (2024)

Table 2 (Cont.)

Code	Definition	References
C6	Non-Interest Income / Total Assets	Zakaria and Purhanudin (2017), Işık (2019), Karadayı (2023), Mehzabin et al. (2023)
C7	Greenhouse Gas Intensity Per Asset	Khan (2011), Sobhani et al. (2012), Korga and Aslanoğlu (2022), Kim et al. (2023), Greer et al. (2024)
C8	Energy Intensity Per Asset	Korga and Aslanoğlu (2022), Atif et al. (2022), Kumar et al. (2023), Wei et al. (2023)
C9	Water Intensity Per Assets	Korga and Aslanoğlu (2022), Huang et al. (2023), Liu et al. (2023)
C10	Water Intensity Per Employee	Özçelik and Avcı Öztürk (2014), Ruberti, (2023)
C11	Paper Consumption Per Employee	Özçelik and Avcı Öztürk (2014), Aydın et al. (2023)
C12	Number Of Branch	Rebai et al. (2016), Stauropoulou and Sardianou (2019), Yıldırım and Yaman (2023)
C13	Number Of ATM	Rebai et al. (2016), Stauropoulou and Sardianou (2019), Yıldırım and Yaman (2023)
C14	Number Of Employees	Khan (2011), Stauropoulou and Sardianou (2019), Yıldırım and Yaman (2023)
C15	Employee Turnover Rate	Khan (2011), Özçelik and Avcı Öztürk (2014), Ielasi et al. (2023)
C16	Total Hours Spent by Firm-Employee Training	Khan (2011), Özçelik and Avcı Öztürk (2014), Korga and Aslanoğlu (2022)
C17	Audit Committee Meetings	Umar et al. (2023), Gbenyi et al. (2023), Wulandari and Barokah(2023), Chronopoulos et al. (2023)
C18	Board Size	De Andres et al. (2005), Laksmana, (2008), Gurol and Lagasio (2022), Wu et al. (2023)
C19	Percentage Of Non-Executive Directors on Board	Oyekale et al. (2022), Muhammad et al. (2023), Oppong and Lartey, (2023), Amin and Cuming, (2023)
C20	Number Of Executives / Company Managers	Kumara and Walakumbura (2023), Khandelwal et al. (2023), Le et al. (2023), Cao et al. (2024)
C21	Board Duration (Years)	Singareddy et al. (2018), Hassan et al. (2023), Tan and Valdez, (2023)

5. IMPLEMENTATION OF THE MSD-MPSI-RAWEC MODEL

In this section of the existing work, the application outcomes of the decision framework for gauging the sustainability performance of banks are presented.

5.1. The Results of MSD Procedure

The decision matrix which includes alternative banks and evaluation criteria is illustrated in Table 3.

Table 3. Initial Decision Matrix

	A1	A2	A3	A4	A5	A6
C1	14.29	13.25	6.45	7.42	6.36	11.39
C2	52.12	58.10	60.53	56.56	56.73	54.55
C3	7.09	6.10	1.45	2.91	2.22	5.88
C4	52.30	50.53	22.13	39.11	30.22	55.60
C5	28.88	32.51	17.50	32.37	30.13	27.24
C6	2.71	3.23	0.47	1.84	1.52	2.41
C7	0.05	0.05	0.03	0.13	0.02	0.04
C8	0.13	0.12	0.09	0.36	0.07	0.11

Table 3 (Cont.)

	A1	**A2**	**A3**	**A4**	**A5**	**A6**
C9	0.04	0.18	0.15	0.60	0.11	0.19
C10	3.71	12.56	10.63	12.06	11.20	14.60
C11	0.03	0.04	0.11	0.17	0.06	0.12
C12	711	837	1038	238	949	801
C13	5553	5450	4075	280	4148	4715
C14	12717	20781	20781	3427	16961	15431
C15	7.21	3	1.7	23.3	2.89	11.9
C16	419661	948237	34704.27	79437.9	41724.06	799097
C17	4	7	4	5	21	4
C18	10	11	9	11	9	12
C19	70.00	90.91	88.89	63.64	88.89	83.33
C20	15	11	14	11	12	17
C21	1	3	3	3	3	1

The elements of the decision matrix shown in Table 3 are normalized via Eq. (2) and (3). Table 4 shows normalized decision matrix.

Table 4. Normalized Decision Matrix

	A1	A2	A3	A4	A5	A6
C1	1.00	0.93	0.45	0.52	0.45	0.80
C2	0.86	0.96	1.00	0.93	0.94	0.90
C3	1.00	0.86	0.20	0.41	0.31	0.83
C4	0.94	0.91	0.40	0.70	0.54	1.00
C5	0.89	1.00	0.54	1.00	0.93	0.84
C6	0.84	1.00	0.15	0.57	0.47	0.75
C7	0.46	0.50	0.74	0.18	1.00	0.57
C8	0.51	0.53	0.71	0.18	1.00	0.60
C9	1.00	0.23	0.27	0.07	0.37	0.22
C10	1.00	0.30	0.35	0.31	0.33	0.25
C11	1.00	0.76	0.27	0.18	0.47	0.25
C12	0.68	0.81	1.00	0.23	0.91	0.77
C13	1.00	0.98	0.73	0.05	0.75	0.85
C14	0.61	1.00	1.00	0.16	0.82	0.74
C15	0.24	0.57	1.00	0.07	0.59	0.14
C16	0.44	1.00	0.04	0.08	0.04	0.84
C17	0.19	0.33	0.19	0.24	1.00	0.19
C18	0.83	0.92	0.75	0.92	0.75	1.00
C19	0.77	1.00	0.98	0.70	0.98	0.92
C20	0.88	0.65	0.82	0.65	0.71	1.00
C21	0.33	1.00	1.00	1.00	1.00	0.33

In Table 5, firstly, the standard deviation of each normalized criterion is calculated. Secondly, the sum of these criteria is found. Next, with the help of Eq. (4), the corrected value of the standard deviation for each criterion is calculated. As seen in the last row of Table 5, the weight value of each criterion is obtained by utilizing Eq. (5).

Table 5. The Results of MSD Procedure

	σ	Σ	σ/Σ	$w_J^{(MSD)}$
C1	0.25	4.14	0.06	0.04
C2	0.05	5.59	0.01	0.01
C3	0.33	3.62	0.09	0.05
C4	0.24	4.49	0.05	0.03
C5	0.17	5.19	0.03	0.02
C6	0.30	3.77	0.08	0.05
C7	0.28	3.45	0.08	0.05
C8	0.27	3.54	0.08	0.05
C9	0.33	2.16	0.15	0.09
C10	0.28	2.54	0.11	0.07
C11	0.33	2.93	0.11	0.07
C12	0.27	4.41	0.06	0.04
C13	0.35	4.36	0.08	0.05
C14	0.31	4.34	0.07	0.04
C15	0.35	2.61	0.13	0.08
C16	0.43	2.45	0.17	0.10
C17	0.32	2.14	0.15	0.09
C18	0.10	5.17	0.02	0.01
C19	0.13	5.34	0.02	0.01
C20	0.14	4.71	0.03	0.02
C21	0.34	4.67	0.07	0.04

5.2. The Results of MPSI Procedure

The decision matrix that was employed in the first step of the application of the MPSI algorithm is shown in Table 3 and the normalized decision matrix is given in Table 4. The averages for the normalized criteria were found by Eq. (6) are reported in Table 6.

Table 6. Mean Values for Normalized Criteria

	Σ/n
C1	0.69
C2	0.93
C3	0.60
C4	0.75
C5	0.86
C6	0.63
C7	0.57
C8	0.59
C9	0.36
C10	0.42
C11	0.49
C12	0.73
C13	0.73
C14	0.72
C15	0.43

Table 6 (Cont.)

	Σ/n
C16	0.41
C17	0.36
C18	0.86
C19	0.89
C20	0.78
C21	0.78

While Eq. (7) was utilized to find the preference variation value, Eq. (8) was employed to compute the MPSI weight values, and the achieved findings are presented in Table 7.

Table 7. The Results of MPSI Procedure

	A1	A2	A3	A4	A5	A6	Σ	$w_j^{(MPSI)}$
C1	0.10	0.06	0.06	0.03	0.06	0.01	0.31	0.04
C2	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
C3	0.16	0.07	0.16	0.04	0.08	0.05	0.56	0.07
C4	0.04	0.03	0.12	0.00	0.04	0.06	0.29	0.04
C5	0.00	0.02	0.11	0.02	0.00	0.00	0.15	0.02
C6	0.04	0.14	0.23	0.00	0.02	0.01	0.46	0.05
C7	0.01	0.01	0.03	0.15	0.18	0.00	0.38	0.05
C8	0.01	0.00	0.02	0.17	0.17	0.00	0.36	0.04
C9	0.41	0.02	0.01	0.08	0.00	0.02	0.54	0.06
C10	0.33	0.02	0.01	0.01	0.01	0.03	0.40	0.05
C11	0.26	0.07	0.05	0.10	0.00	0.06	0.54	0.06
C12	0.00	0.01	0.07	0.26	0.03	0.00	0.37	0.04
C13	0.07	0.06	0.00	0.46	0.00	0.01	0.61	0.07
C14	0.01	0.08	0.08	0.31	0.01	0.00	0.49	0.06
C15	0.04	0.02	0.32	0.13	0.02	0.09	0.62	0.07
C16	0.00	0.35	0.14	0.11	0.13	0.19	0.92	0.11
C17	0.03	0.00	0.03	0.01	0.41	0.03	0.51	0.06
C18	0.00	0.00	0.01	0.00	0.01	0.02	0.05	0.01
C19	0.01	0.01	0.01	0.04	0.01	0.00	0.08	0.01
C20	0.01	0.02	0.00	0.02	0.01	0.05	0.10	0.01
C21	0.20	0.05	0.05	0.05	0.05	0.20	0.59	0.07

5.3. Combined Weights

The optimal criteria weight values computed by applying Eq. (9) are reported in Table 8.

Table 8. Final Weight Values of Criteria

	w_j
C1	0.036
C2	0.003
C3	0.061
C4	0.034
C5	0.019

Table 8 (Cont.)	
	w_j
C6	0.051
C7	0.047
C8	0.044
C9	0.078
C10	0.058
C11	0.066
C12	0.040
C13	0.061
C14	0.051
C15	0.077
C16	0.107
C17	0.075
C18	0.009
C19	0.012
C20	0.015
C21	0.058

5.4. The Results of RAWEC Procedure

The decision matrix that was utilized in the application of the RAWEC technique is demonstrated in Table 3. Next, the normalized decision matrix is form with the aid of Eq. (10) and Eq. (11). This matrix is indicated in Table 9.

Table 9. Normalized Initial Decision Matrix

	Benefit Normalisation (v_{ij})						**Cost Normalisation (v'_{ij})**					
	A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**
C1	1.00	0.93	0.45	0.52	0.45	0.80	0.45	0.48	0.99	0.86	1.00	0.56
C2	0.86	0.96	1.00	0.93	0.94	0.90	1.00	0.90	0.86	0.92	0.92	0.96
C3	1.00	0.86	0.20	0.41	0.31	0.83	0.20	0.24	1.00	0.50	0.65	0.25
C4	0.94	0.91	0.40	0.70	0.54	1.00	0.42	0.44	1.00	0.57	0.73	0.40
C5	0.89	1.00	0.54	1.00	0.93	0.84	0.61	0.54	1.00	0.54	0.58	0.64
C6	0.84	1.00	0.15	0.57	0.47	0.75	0.17	0.15	1.00	0.26	0.31	0.20
C7	0.46	0.50	0.74	0.18	1.00	0.57	0.40	0.36	0.25	1.00	0.18	0.32
C8	0.51	0.53	0.71	0.18	1.00	0.60	0.35	0.34	0.25	1.00	0.18	0.30
C9	1.00	0.23	0.27	0.07	0.37	0.22	0.07	0.30	0.26	1.00	0.18	0.32
C10	1.00	0.30	0.35	0.31	0.33	0.25	0.25	0.86	0.73	0.83	0.77	1.00
C11	1.00	0.76	0.27	0.18	0.47	0.25	0.18	0.23	0.65	1.00	0.38	0.71
C12	0.68	0.81	1.00	0.23	0.91	0.77	0.33	0.28	0.23	1.00	0.25	0.30
C13	1.00	0.98	0.73	0.05	0.75	0.85	0.05	0.05	0.07	1.00	0.07	0.06
C14	0.61	1.00	1.00	0.16	0.82	0.74	0.27	0.16	0.16	1.00	0.20	0.22
C15	0.24	0.57	1.00	0.07	0.59	0.14	0.31	0.13	0.07	1.00	0.12	0.51
C16	0.44	1.00	0.04	0.08	0.04	0.84	0.08	0.04	1.00	0.44	0.83	0.04
C17	0.19	0.33	0.19	0.24	1.00	0.19	1.00	0.57	1.00	0.80	0.19	1.00
C18	0.83	0.92	0.75	0.92	0.75	1.00	0.90	0.82	1.00	0.82	1.00	0.75
C19	0.77	1.00	0.98	0.70	0.98	0.92	0.91	0.70	0.72	1.00	0.72	0.76
C20	0.88	0.65	0.82	0.65	0.71	1.00	0.73	1.00	0.79	1.00	0.92	0.65
C21	0.33	1.00	1.00	1.00	1.00	0.33	1.00	0.33	0.33	0.33	0.33	1.00

After this computation, Eq. (12)-(14) are applied to obtain the deviations from the criterion weights and the values of Ω_i. The results of these calculations and the ranking orders of the alternatives are indicated in Table 10. According to the outcomes indicated in Table 10, it is observed that A2 and A1 are ranked as the top two banks, while A3 and A4 are ranked as the worst banks.

Table 10. Final Ranking Order Using the RAWEC Method

	n_{ij}	n'_{ij}	Ω_i	Rank
A1	0.32	0.64	0.34	2
A2	0.27	0.68	0.43	1
A3	0.49	0.41	-0.09	5
A4	0.69	0.22	-0.51	6
A5	0.40	0.58	0.19	3
A6	0.44	0.54	0.10	4

6. SENSITIVITY ANALYSIS

This section conducts a series of sensitivity analysis tests to demonstrate the robustness, stability and validity of the recommended combined MCDM approach. The analysis was performed in four stages. Firstly, the current study investigated the effects of changes in weight values of criteria on the ranking performance of alternatives via 100 scenarios. Secondly, the effect of changing the values of the ψ parameter on the ranking order of the alternatives is examined. Thirdly, this study examines the influence of removing each alternative on the final ranking results of the recommended framework to test its robustness. Finally, we compare the ranking results of recommended MCDM framework to those obtained by applying various MCDM approaches.

6.1. Exploring the Changes in Criteria Weights

A total of 100 scenarios were generated to assess the effects of criterion weight changes. Each scenario decreased the weight of the most influential criterion (C16) by 2%. The following equation was utilized to estimate the weights of the remaining criteria in each scenario:

$$w_n^* = w_n \frac{(1-w_{21}^*)}{(1-w_{21})} \text{ for } n \neq 16 \quad (15)$$

Here, w_n^* denotes the new value of w_n in the next scenario. For instance, for the first scenario (S1), the new weight value for C16 is obtained as follows:

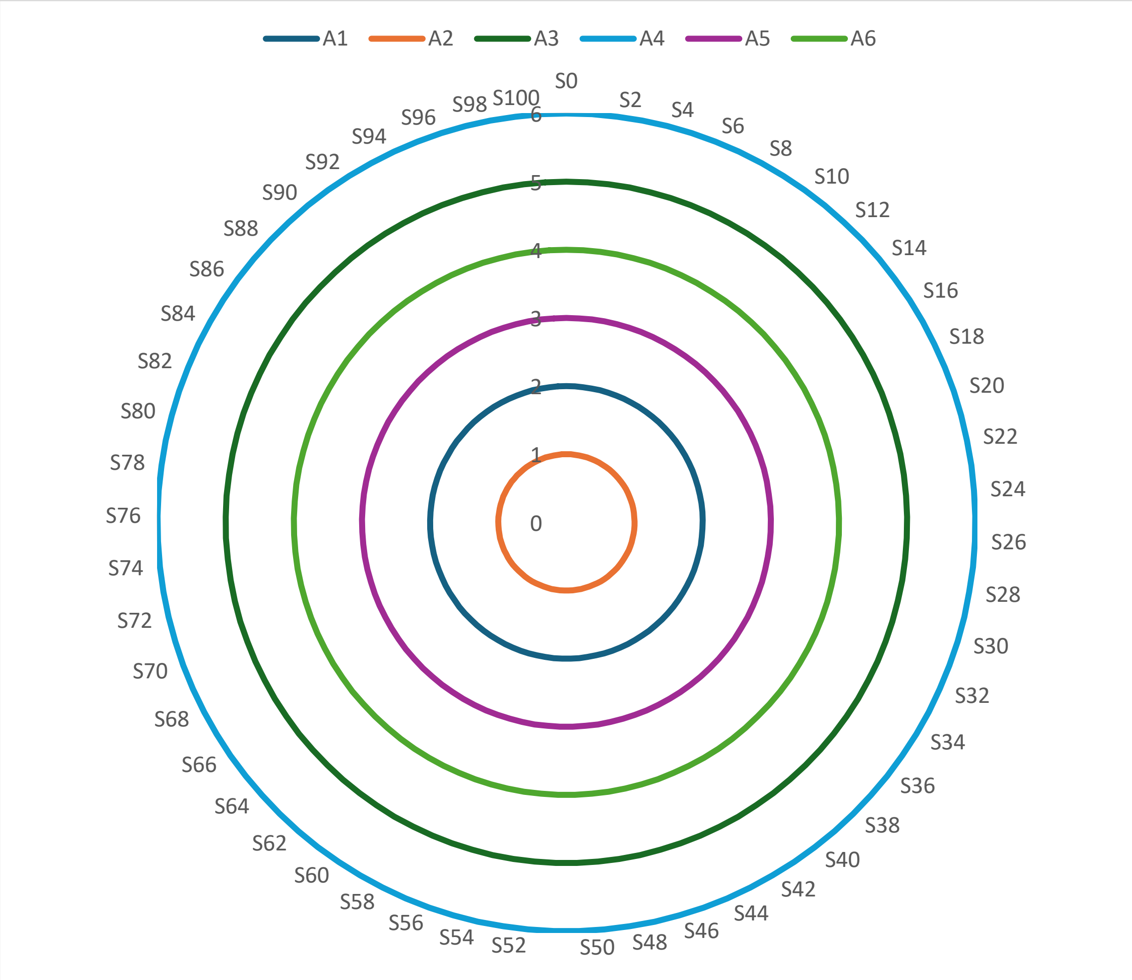
$$w_{16}^* \cong 0.1070 \times 0.98 \cong 0.1049$$

The new weight value of C1 in S1 is computed as indicated below.

$$w_1^* \cong 0.0365 \frac{(1-0.1049)}{(1-0.1070)} \cong 0.0366$$

The weights of the other 20 criteria were found by applying Eq. (15). Next, we created new weight vectors based on 100 different scenarios and tried to analyze their impact on the ranking positions of options. The alternatives were re-ranked using 100 scenarios and the results are shown in Figure 2. When Figure 2 is analyzed, it is determined that there is no change in the ranking of any alternative.

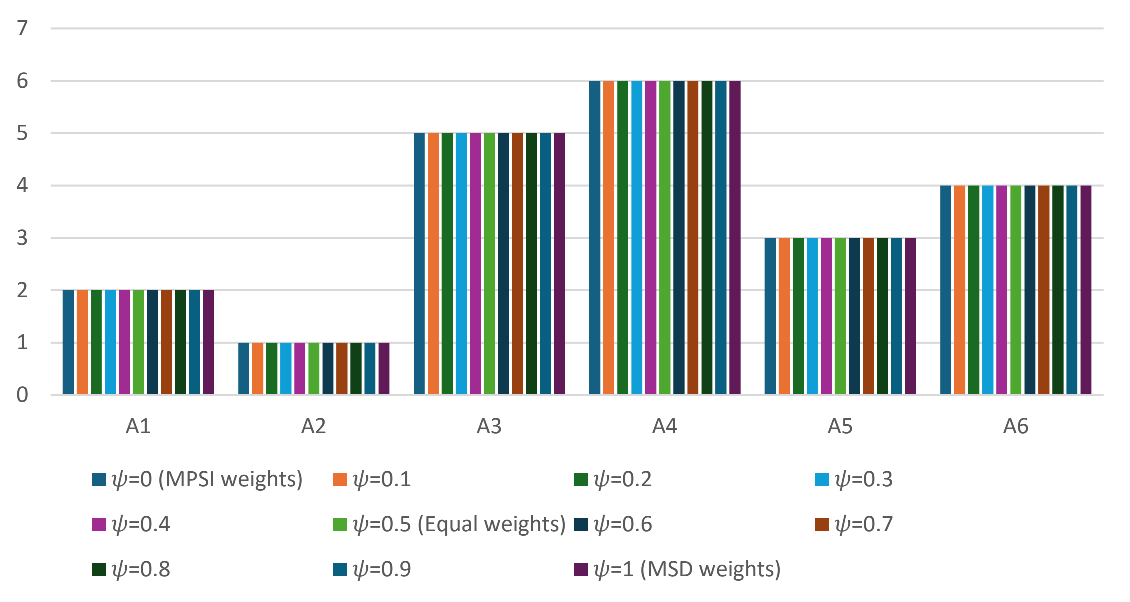
Figure 2. Re-ranking of Alternatives Based on the New Weights for Criteria



6.2. Analyzing the Impact of Changing Values of the ψ Parameter

The value of the parameter ψ was set as 0.5 to compute the integrated weights of criteria. By identifying the values of the parameter ψ as integers ranging from 1 to 10, the weight values of the criteria and their influence on the ranking of the options were investigated. The ranking orders of options with regard to the 10 scenarios are illustrated in Figure 3. When the results displayed in Figure 3 are considered, it is understood that there is no significant change in the ranking positions of the alternatives.

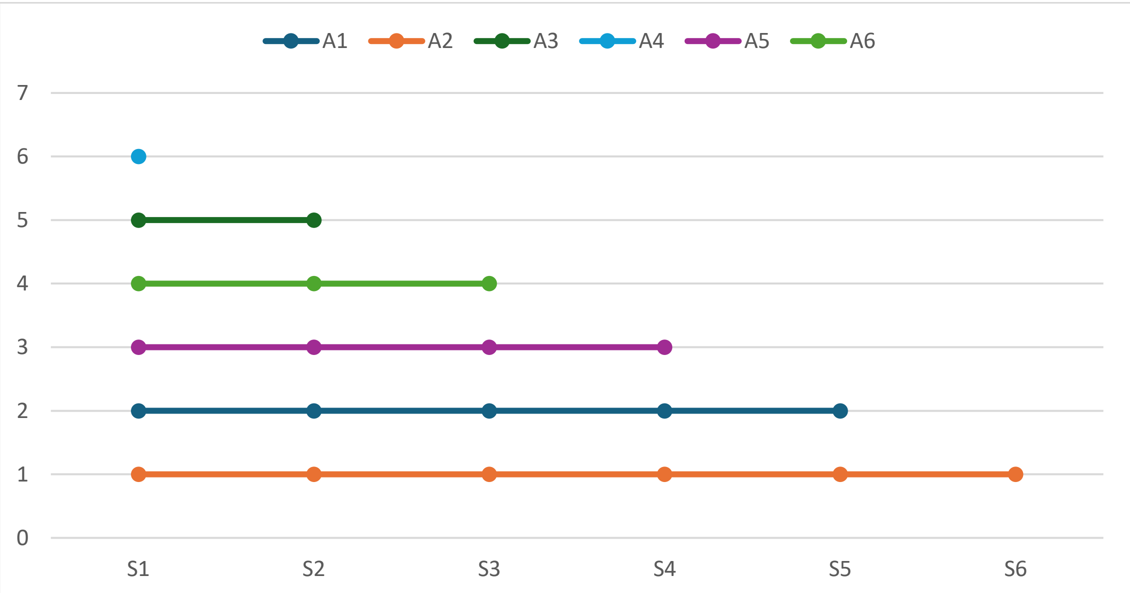
Figure 3. Re-ranking of Alternatives According to a Variety of Values of ψ Parameter



6.3. Examining the Impact of the Rank Reversal Phenomenon on the Ranking Order

To understand the effectiveness of the introduced MCDM tool to the rank reversal issue, scenarios based on the elimination of the least important alternative were developed. Accordingly, in each scenario, the worst alternatives were dropped from the analysis, respectively, until the best alternative remained. The results obtained from six scenarios based on the elimination of the least important alternative are presented in Figure 4. The findings from the scenarios based on the elimination of the least important alternative are presented in Figure 4. As can be seen in Figure 4, the elimination of the worst alternatives from the analysis does not influence the initial ranking results, which shows that the proposed MCDM tool is robust and consistent at the maximum level.

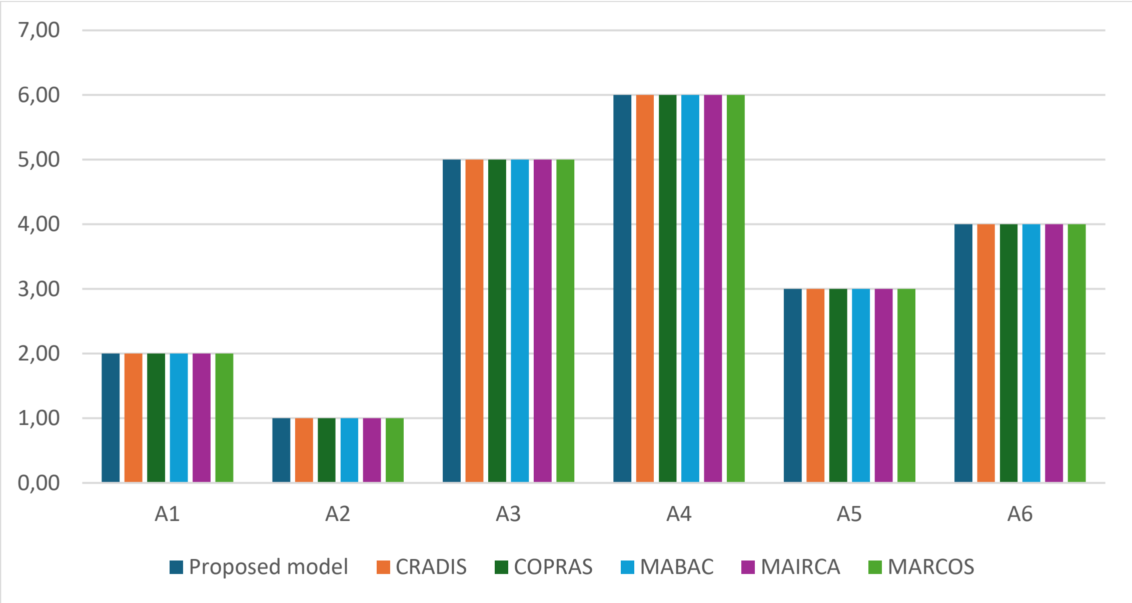
Figure 4. Alternatives' Ranking Orders Based on Various Scenarios



6.4. Comparison of the Suggested Hybrid Methodology with the Various MCDM Tools

The results achieved by the implementation of the suggested hybrid MCDM methodology are compared with the results of various MCDM methods like CRADIS (Puška et al., 2022), COPRAS (Zavadskas et al., 2001), MABAC (Pamučar and Ćirović, 2015), MAIRCA (Pamučar et al., 2014), and MARCOS (Stević et al., 2020) and the results based on the comparison are shown in Figure 5. The outcomes from Figure 5 means that the suggested hybrid MCDM tool is a maximally robust and reliable.

Figure 5. Alternatives' Ranking Results According to Different MCDM Methods



7. DISCUSSION AND PRACTICAL, AND MANAGERIAL IMPLICATIONS

Assessing the overall performance of the banking industry based on financial, environmental, social and corporate governance is of great importance with regards to increasing the quality of service offered to customers, effectively managing risks and developing new products. Analyzing sustainability performance based on a solid and effective methodological framework, taking into account financial and non-financial performance indicators, makes it easier for various stakeholder groups related to the banking sector to make more practical, powerful and rational decisions.

The current paper gauging the multidimensional sustainability performance of banks has some practical implications as follows.

- The first practical contribution of the application is to provide a new and integrated framework to analyze the multidimensional sustainability performance of banks.
- The proposed decision framework has a simple and understandable mathematical procedure that DMs without advanced mathematical knowledge can easily implement.
- The combined weighting system, which integrates MSD and MPSI algorithms, contributes to obtaining more optimal results regarding the weight values of the criteria.

- The findings from sensitivity and comparative analysis demonstrate that the introduced decision tool is maximally robust and consistent.
- The proposed methodology for analyzing bank multidimensional sustainability performance is not sensitive to rank reversal, which is one of the important problems seen in MCDM applications.

The managerial implications of the current study are described below.

- The results of this study, which concentrates on the multidimensional performance of banks, one of the most significant actors of the financial intermediation process, provide critical implications for the mechanisms that regulate and supervise the banking industry, regarding the monitoring of bank performance and the sustainability of the financial system.
- Comparing the performance of banks in terms of multidimensional sustainability forms the basis of their operational and sustainability-related activities and provides vital insights concerning the success of the implemented strategies to all relevant stakeholders.
- The findings obtained through the proposed performance evaluation tool can help the bank's board of directors and senior management team to improve the banks' overall performance and achieve sustainable competitive advantage.

8. CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

Due to social, environmental and governance sustainability concerns, multidimensional analysis of bank performance has become a significant and critical issue for all stakeholders in the banking sector. In the current article, an integrated MCDM model is suggested to address decision problem regarding bank multi-dimensional sustainability performance assessment. In this context, MSD-MPSI-RAWEC model are integrated for the first time.

According to the integrated weighting outcomes reported in Table 8, C16 (Total hours spent by firm-employee training), C9 (Water intensity per assets), and C15 (Employee turnover rate) are the most critical criteria influencing sustainability performance. This finding is similar to the results of Ecer (2019), Doğan and Kılıç (2022), Yıldırım and Yaman (2023), but different from the results of Alp et al. (2015), Ersoy (2018) and Bektaş (2023). On the other hand, based on the findings from the RAWEC methodology shown in Table 10, it can be concluded that A2 (Garanti BBVA) is identified as the best alternative, followed by A1 (Akbank), A5 (Vakıfbank), A6 (Yapı Kredi), A3 (Halkbank), and A4 (Şekerbank). This result is similar to the results obtained by Özçelik and Öztürk (2014), Kestane et al. (2019), Doğan and Kılıç (2022), while it is different from the results obtained by Eş and Kamacı (2020) and Bektas (2022) and Terzioğlu et al. (2023). The reason for these differences can generally be attributed to the performance criteria used in the aforementioned studies, the CRM procedures used, the sample of banks selected and the periods examined in the analyses.

Further, the accuracy and validity of the introduced methodology is checked in four phases. In the first phase, the influences of the modifications concerning the weight values of criteria on the initial alternative rank were investigated. The impact of changing values of the ψ parameter is analyzed in the second phase. In the third stage, the introduced MCDM tool's resistance to the rank reversal issue was analyzed and fourth stage and last stage of the robustness examination, the findings of introduced methodology were compared to the results of some common and robust decision-making approaches. The conducted sensitivity study's results support that the recommended MCDM tool is a stable, reliable, and resistant environment for making decisions.

The key contribution of the existing manuscript to the practitioners and researchers who work in the field of banking is to introduce a hybrid MCDM tool based on based on MSD, MPSI, and RAWEC to solve the performance assessment problem in banking industry. Another valuable contribution is presenting a novel criteria set based on financial and non-financial indicators of banks. Also, DMs can easily implement this model without advanced mathematical information and software like R, MATLAB, etc.

On the other hand, some limitations of existing manuscript exist; and these limitations can be summarized as follows: i) it can be accepted that the number of banks ıncluded in the present work is relatively low to generalize the obtained results. ii) the analysis period is limited due to the data.

For future scientific studies, we recommend that a more comprehensive performance assessment be carried out by including different indicators in the analysis process. Additionally, considering research problem, the other robust MCDM techniques such as LOPCOW, WENSLO, CoCoSo, AROMAN, ARTASI, ALWAS, etc. can be employed for analyzing bank multi-dimensional sustainability performance.

The study does not necessitate Ethics Committee permission.

The study has been crafted in adherence to the principles of research and publication ethics.

The authors declare that there exists no financial conflict of interest involving any institution, organization, or individual(s) associated with the article. Furthermore, there are no conflicts of interest among the authors themselves.

The authors contributed equally to the entire process of the research.

REFERENCES

Ali, J., Hussain, K. N., Alnoor, A., Muhsen, Y. R., & Atiyah, A. G. (2024). Benchmarking methodology of banks based on financial sustainability using CRITIC and RAFSI techniques. *Decision Making: Applications in Management and Engineering*, *7*(1), 315-341. https://doi.org/10.31181/dmame712024945

Ali, M., Azmi, W., Kowsalya, V., & Rizvi, S. A. R. (2023). Interlinkages between stability, carbon emissions and the ESG disclosures: Global evidence from banking industry. *Pacific-Basin Finance Journal*, (82), 102154. https://doi.org/10.1016/j.pacfin.2023.102154

Alp, İ., Öztel, A., & Köse, M. S. (2015). Entropi tabanlı MAUT yöntemi ile kurumsal sürdürülebilirlik performansı ölçümü: Bir vaka çalışması. *Ekonomik ve Sosyal Araştırmalar Dergisi, 11*(2), 5-81.

Amile, M., Sedaghat, M., & Poorhossein, M. (2013). Performance evaluation of banks using fuzzy AHP and TOPSIS, case study: State-owned banks, partially private and private banks in Iran. *Caspian Journal of Applied Sciences Research, 2*(3), 128-138.

Amin, Q. A., & Cumming, D. (2023). The politician as a CEO, corporate governance, and firm value. *Journal of International Financial Markets, Institutions and Money*, (87), 101804. https://doi.org/10.1016/j.intfin.2023.101804

Aras, G., & Hacioglu Kazak, E. (2022). Enhancing firm value through the lens of ESG materiality: Evidence from the banking sector in OECD countries. *Sustainability*, *14*(22), 15302. https://doi.org/10.3390/su142215302

Atif, M., Alam, M. S., & Islam, M. S. (2023). Firm-level energy and carbon performance: Does sustainable investment matter? *Business Strategy and the Environment*, *32*(4), 2275-2295. https://doi.org/10.1002/bse.3248

Avşarligil, N., Doğru, E., & Ciğer, A. (2023). The bank performance ranking in the emerging markets: A case of Turkey. *Sosyoekonomi*, *31*(55), 69-84. https://doi.org/10.17233/sosyoekonomi.2023.01.04

Aydin, M., Koc, P., & Tumay, M. (2023). Investigating the environmental Kuznets curve hypothesis with recovered paper consumption, human development index, urbanization, and forest footprint. *International Journal of Environmental Science and Technology, 20*(8), 9053-9064. https://doi.org/10.1007/s13762-023-05049-7

Bektaş, S. (2022). Türkiye'deki kamu sermayeli bankaların sürdürülebilirlik performanslarının hibrit ÇKKV model ile değerlendirilmesi: 2014-2021 dönemi MEREC-ARAS modeli örneği. *Anadolu Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 23*(4), 426-442. https://doi.org/10.53443/anadoluibfd.1150277

Bektaş, S. (2023). Özel sermayeli bir mevduat bankasının sürdürülebilirlik performansının hibrit ÇKKV modeliyle değerlendirilmesi: 2009-2021 dönemi Akbank örneği. *İzmir İktisat Dergisi, 38*(4), 884-907. https://doi.org/10.24988/ije.1216968

Brei, M., Mohan, P., Barahona, A. P., & Strobl, E. (2024). Transmission of natural disasters to the banking sector: Evidence from thirty years of tropical storms in the Caribbean. *Journal of International Money and Finance,* 141, 103008. https://doi.org/10.1016/j.jimonfin.2023.103008

Buallay, A., Fadel, S. M., Alajmi, J., & Saudagaran, S. (2021). Sustainability reporting and bank performance after financial crisis: Evidence from developed and developing countries. *Competitiveness Review: An International Business Journal*, *31*(4), 747-770.

Bucevska, V., & Hadzi Misheva, B. (2017). The determinants of profitability in the banking industry: Empirical research on selected Balkan Countries. *Eastern European Economics, 55*(2), 146-167. https://doi.org/10.1080/00128775.2016.1260473

Cao, Z., Upadhyay, A., & Zeng, H. (2024). Are all female directors equal? Incentives and effectiveness of female independent directors. *Journal of Banking & Finance*, 107110. https://doi.org/10.1016/j.jbankfin.2024.107110

Chatzitheodorou, K., Tsalis, T. A., Tsagarakis, K. P., Evangelos, G., & Ioannis, N. (2021). A new practical methodology for the banking sector to assess corporate sustainability risks with an application in the energy sector. *Sustainable Production and Consumption*, (27), 1473-1487. https://doi.org/10.1016/j.spc.2021.03.005

Chronopoulos, D. K., Rempoutsika, L. M., & Wilson, J. O. (2024). Audit committee oversight and bank financial reporting quality. *Journal of Business Finance & Accounting*, *51*(1-2), 657-687. https://doi.org/10.1111/jbfa.12738

Coetzee, J., & Genukile, L. (2020). The short-and long-run drivers of lending behaviour by South African banks. *African Journal of Economic and Management Studies*, *11*(4), 639-651.

Cui, X., Xu, N., Yan, X., & Zhang, W. (2023). How does social credit system constructions affect corporate carbon emissions? Empirical evidence from Chinese listed companies. *Economics Letters*, (231), 111309. https://doi.org/10.1016/j.econlet.2023.111309

De Andres, P., Azofra, V., & Lopez, F. (2005). Corporate boards in OECD countries: Size, composition, functioning and effectiveness. *Corporate Governance: An International Review*, *13*(2), 197-210. https://doi.org/10.1111/j.1467-8683.2005.00418.x

Doğan, M. (2013). Measuring bank performance with gray relational analysis: The case of Turkey. *Ege Akademik Bakis*, *13*(2), 215-225.

Doğan, B. & Kılıç, M. B. (2022). Kurumsal sürdürülebilirlik performansının Entropi ve Gri İlişkisel analizi ile değerlendirilmesi: Bankacılık sektöründe bir uygulama. *Journal of Mehmet Akif Ersoy University Economics and Administrative Sciences Faculty*, *9*(3), 2027-2057. https://doi.org/10.30798/makuiibf.1097637

Ecer, F. (2019). Özel sermayeli bankaların kurumsal sürdürülebilirlik performanslarının değerlendirilmesine yönelik çok kriterli bir yaklaşım: Entropi-ARAS bütünleşik modeli. *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi, 14*(2), 365-390. https://doi.org/10.17153/oguiibf.470336

Ersoy, N. (2018). Entropy tabanlı bütünleşik ÇKKV yaklaşımı ile kurumsal sürdürülebilirlik performans ölçümü. *Ege Academic Review*, *18*(3), 367-385.

Eş, A. & Kamacı, T. B. (2020). Bankaların sürdürülebilirlik performanslarının EDAS ve ARAS yöntemleriyle değerlendirilmesi. *Bolu Abant İzzet Baysal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 20*(4), 807-831. https://doi.org/10.11616/basbed.v20i58861.809533

Feng, Z., & Wu, Z. (2023). ESG disclosure, REIT debt financing and firm value. *The Journal of Real Estate Finance and Economics*, *67*(3), 388-422. https://doi.org/10.1007/s11146-021-09857-x

Gaur, S. S., Vasudevan, H., & Gaur, A. S. (2011). Market orientation and manufacturing performance of Indian SMEs: Moderating role of firm resources and environmental factors. *European Journal of Marketing*, *45*(7/8), 1172-1193.

Gazel, Y. H., Altinirmak, S., & Karamaşa, Ç. (2021). Türkiye'de faaliyet gösteren ticari bankaların çok kriterli karar verme yöntemlerine göre performanslarının sıralanması. *Sosyoekonomi*, *29*(48), 161-180. https://doi.org/10.17233/sosyoekonomi.2021.02.09

Gbenyi, G. T., Tsegba, I. N., & Duenya, M. I. (2023). Audit committee attributes and share price reaction of listed Deposit money banks in Nigeria. *Asian Journal of Economics, Business and Accounting*, *23*(4), 1-16. https://doi.org/10.9734/ajeba/2023/v23i4926

Gishkori, M. A. and Ullah, N. (2013). Technical efficiency of Islamic and commercial banks: Evidence from Pakistan using DEA model (2007-2011). *Journal of Business and Management*, *7*(4), 68-76.

Gligorić, M., Gligorić, Z., Lutovac, S., Negovanović, M., & Langović, Z. (2022). Novel hybrid MPSI–MARA decision-making model for support system selection in an underground mine. *Systems*, *10*(6), 248. https://doi.org/10.3390/systems10060248

Greer, F., Raftery, P., & Horvath, A. (2024). Considerations for estimating operational greenhouse gas emissions in whole building life-cycle assessments. *Building and Environment*, 111383. https://doi.org/10.1016/j.buildenv.2024.111383

Gurol, B., & Lagasio, V. (2022). Women board members' impact on ESG disclosure with environment and social dimensions: Evidence from the European banking sector. *Social Responsibility Journal*, *19*(1), 211-228.

Hassan, M. K., Houston, R., Karim, M. S., & Sabit, A. (2023). CEO duality and firm performance during the 2020 coronavirus outbreak. *The Journal of Economic Asymmetries*, (27), e00278. https://doi.org/10.1016/j.jeca.2022.e00278

Havrylchyk, O. (2006). Efficiency of the Polish banking industry: Foreign versus domestic banks. *Journal of Banking & Finance*, *30*(7), 1975-1996. https://doi.org/10.1016/j.jbankfin.2005.07.009

Hayajneh, O. S., & Yassine, F. L. A. (2011). The impact of working capital efficiency on profitability–an empirical analysis on Jordanian manufacturing firms. *International Research Journal of Finance and Economics*, (66), 67-69.

Huang, D., Wen, F., Li, G., & Wang, Y. (2023). Coupled development of the urban water-energy-food nexus: A systematic analysis of two megacities in China's Beijing-Tianjin-Hebei area. *Journal of Cleaner Production*, (419), 138051. https://doi.org/10.1016/j.jclepro.2023.138051

Ielasi, F., Bellucci, M., Biggeri, M., & Ferrone, L. (2023). Measuring banks' sustainability performances: The BESGI score. *Environmental Impact Assessment Review*, (102), 107216. https://doi.org/10.1016/j.eiar.2023.107216

Işık, O. (2017). Internal determinants of profitability of state, private and foreign owned commercial banks operating in Turkey. *Journal of Economics Finance and Accounting*, *4*(3), 342-353. https://doi.org/10.17261/Pressacademia.2017.701

Işık, Ö., & Belke, M. (2017). An Empirical analysis of the determinants of net interest margins of Turkish listed banks: panel data evidence from post-crisis era. *Sosyoekonomi*, *25*(34). 227-245.

Işık, Ö. (2019). Türk Mevduat bankaciliği sektörünün finansal performanslarinin Entropi tabanli ARAS yöntemi kullanilarak değerlendirilmesi. *Finans Ekonomi ve Sosyal Araştırmalar Dergisi*, *4*(1), 90-99. https://doi.org/10.29106/fesa.533997

Işık, Ö. (2020). SD Tabanlı MABAC ve WASPAS yöntemleriyle kamu sermayeli kalkınma ve yatırım bankalarının performans analizi. *Uluslararası İktisadi ve İdari İncelemeler Dergisi*, (29), 61-78. https://doi.org/10.18092/ulikidince.705148

Işık, Ö. (2022). Covid-19 Salgınının katılım bankacılığı sektörünün performansına etkisinin MEREC-PSI-MAIRCA modeliyle incelenmesi. *Nişantaşı Üniversitesi Sosyal Bilimler Dergisi*, *2*(10), 363-385. https://doi.org/10.52122/nisantasisbd.1167829

Işık, Ö. (2023). ESG activities and financial performance in banking industry, *International Journal of Insurance and Finance*, 53-64.

Işık, Ö., Çalık, A., & Shabir, M. (2024). A Consolidated MCDM framework for overall performance assessment of listed insurance companies based on ranking strategies, *Computational Economics*, 1-42. https://doi.org/10.1007/s10614-024-10578-5

Işık, Ö., Shabir, M., & Belke, M. (2023). Is there a causal relationship between financial performance and premium production? Evidence from Turkish insurance industry. *Mehmet Akif Ersoy Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 10*(2), 1388-1412. https://doi.org/10.30798/makuiibf.1220299

Karadayi, N. (2023). Determinants of return on assets. *European Journal of Business and Management Research*, *8*(3), 37-44.

Kestane, A., & Kurnaz, N. (2019). Finans kuruluşlarında Gri İlişkisel Analiz yöntemi ile sürdürülebilirlik performansı değerlendirmesi: türkiye bankacılık sektöründe uygulama. *Turkish Studies-Economics, Finance, Politics, 14*(4), 1323-1358.

Khalaf, B. A., Yaseen, H., & Omet, G. (2015). The evolution of bank competition: Have conditions changed in the Jordanian banking sector? *In Economic Forum 5*(3), 100-107. http://dx.doi.org/10.6007/IJARAFMS/v5-i3/1802

Khan, H. U. Z., Azizul Islam, M., Kayeser Fatima, J., & Ahmed, K. (2011). Corporate sustainability reporting of major commercial banks in line with GRI: Bangladesh evidence. *Social responsibility journal*, *7*(3), 347-362.

Khandelwal, C., Kumar, S., Tripathi, V., & Madhavan, V. (2023). Joint impact of corporate governance and risk disclosures on firm value: Evidence from emerging markets. *Research in International Business and Finance*, (66), 102022. https://doi.org/10.1016/j.ribaf.2023.102022

Kim, S. J., Kim, H., & Atukeren, E. (2023). Effects of board Independence on greenhouse gas emissions and financial consequences: Evidence from South Korea. *Environments*, *10*(3), 56. https://doi.org/10.3390/environments10030056

Korga, S. ve Aslanoğlu, S. (2022). Sürdürülebilirlik performansı ile finansal performans ilişkisi üzerine bir araştırma. *Selçuk Üniversitesi Sosyal Bilimler Meslek Yüksekokulu Dergisi*, *25*(2), 633-645. https://doi.org/10.29249/selcuksbmyd.1114641

Kumar, A., Mittal, A., & Pradhan, A. K. (2023). Magnitude and determinants of energy intensity: Evidence from Indian firms. *Environmental Science and Pollution Research*, 30(2), 3270-3281. https://doi.org/10.1007/s11356-022-22346-9

Kumar, P., & Sharma, D. (2023). Benchmarking the financial performance of Indian commercial banks by A hybrid MCDM approach. *International Journal of Process Management and Benchmarking*, *15*(3), 285-309. https://doi.org/10.1504/IJPMB.2023.134147

Kumar, P., & Sharma, D. (2024). Prioritising the financial performance of Indian private sector banks by a hybrid MCDM approach. *International Journal of Process Management and Benchmarking*, *16*(4), 490-511. https://doi.org/10.1504/IJPMB.2024.137145

Kumara, A. A. A. G., & Walakumbura, S. H. M. L. (2023). Corporate governance on financial performance: Evidence from listed commercial banks in Sri Lanka. *KJMS*, *5*(1), 66-76. https://doi.org/10.4038/kjms.v5i1.63

Laha, S. & Biswas, S. (2019). A Hybrid unsupervised learning and multi-criteria decision-making approach for performance evaluation of Indian banks. *Accounting*, *5*(4), 169-184.

Laksmana, I. (2008). Corporate board governance and voluntary disclosure of executive compensation practices. *Contemporary accounting research*, *25*(4), 1147-1182. https://doi.org/10.1506/car.25.4.8

Le, H. T. M., Ting, I. W. K., Kweh, Q. L., & Ngo, H. L. T. (2023). CEO duality, board size and firm performance: evidence in Vietnam. *International Journal of Business Excellence*, *29*(1), 98-120.

Liu, R., Dong, X., Wang, X., Zhang, P., Liu, M., & Zhang, Y. (2023). Relationship and driving factors between urbanization and natural ecosystem health in China. *Ecological Indicators*, (147), 109972. https://doi.org/10.1080/1540496X.2014.998945

Love, I. and Rachinsky, A. (2015). Corporate governance and bank performance in emerging markets: Evidence from Russia and Ukraine, *Emerging Markets Finance and Trade*, *51*(2), 101-121.

Mandic, K., Delibasic, B., Knezevic, S., and Benkovic, S. (2014). Analysis of the financial parameters of Serbian banks through the application of the fuzzy AHP and TOPSIS methods. *Economic Modelling*, (43), 30-37. https://doi.org/10.1016/j.econmod.2014.07.036

Maniya, K., & Bhatt, M. G. (2010). A selection of material using a novel type decision-making method: Preference selection index method. *Materials & Design*, *31*(4), 1785-1789. https://doi.org/10.1016/j.matdes.2009.11.020

McGuire, J.B., Sundgren, A. and Schneeweis, T. (1988). Corporate social responsibility and firm financial performance, *The Academy of Management Journal*, *31*(4), 854-72. https://doi.org/10.5465/256342

Mehzabin, S., Shahriar, A., Hoque, M. N., Wanke, P., & Azad, M. A. K. (2023). The effect of capital structure, operating efficiency, and non-interest income on bank profitability: new evidence from Asia. *Asian Journal of Economics and Banking*, *7*(1), 25-44.

Mengtao, C., Da-peng, Y., Wei-qi, Z., & Qi-jun, W. (2023). How does ESG disclosure improve stock liquidity for enterprises-empirical evidence from China. *Environmental Impact Assessment Review*, (98), 106926. https://doi.org/10.1016/j.eiar.2022.106926

Milenković, N., Radovanov, B., Kalaš, B. & Horvat, A. M. (2022). External two stage DEA analysis of bank efficiency in West Balkan Countries. *Sustainability*, *14*(2), 978. https://doi.org/10.3390/su14020978

Mili, M., Sahut, J. M., Trimeche, H., & Teulon, F. (2017). Determinants of the capital adequacy ratio of foreign banks' subsidiaries: The role of interbank market and regulation. *Research in international business and finance*, (42), 442-453. https://doi.org/10.1016/j.ribaf.2016.02.002

Muhammad, M. I., Tukur, Y., Dabari, I. J., & Hanga, B. Y. (2023). Board attributes and credit risk exposure of listed deposit money banks in Nigeria: The moderating effect of risk committee size. *Journal of Economics, Management and Trade*, *29*(8), 99-112. https://doi.org/10.9734/jemt/2023/v29i81118

Munteanu, I. (2012). Bank liquidity and its determinants in Romania. *Procedia Economics and Finance*, (3), 993-998. https://doi.org/10.1016/S2212-5671(12)00263-8

Oppong, S., & Safo Lartey, J. K. (2023). Towards a psychology of corporate governance: Theoretical insights on non-executive director and CEO performance. *Business Perspectives and Research*, 1-16. https://doi.org/10.1177/22785337221148856

Oyekale, P. J., Olaoye, S. A., & Nwaobia, A. N. (2022). Corporate governance mechanisms and social sustainability disclosure in non-financial firms listed in Nigeria. *Current Trends in Social and Management Sciences Research*, *1*(1), 14-35.

Özçelik, F., & Avcı Öztürk, B. (2014). Evaluation of banks' sustainability performance in Turkey with Grey Relational Analysis. *Journal of Accounting & Finance/Muhasebe ve Finansman Dergisi*, (63), 189-210. https://doi.org/10.25095/mufad.396484

Pamučar, D., & Ćirović, G. (2015). The selection of transport and handling resources in logistics centers using Multi-Attributive Border Approximation Area Comparison (MABAC). *Expert systems with applications, 42*(6), 3016-3028. https://doi.org/10.1016/j.eswa.2014.11.057

Pamučar, D., Vasin, L., & Lukovac, L. (2014). *Selection of railway level crossings for investing in security equipment using hybrid DEMATEL-MARICA model* [Conference presentation]. XVI international scientific-expert conference on railway, Railcon. 89-92.

Prabowo, F. P. S. R., Sarita, B., Syaifuddin, D. T., Saleh, S., Hamid, W., & Budi, N. (2018). Effect of equity to assets ratio (EAR), size, and loan to assets ratio (LAR) on bank performance. *IOSR Journal of Economics and Finance, 9*(4), 1-16.

Puška, A., Stević, Ž., & Pamučar, D. (2022). Evaluation and selection of healthcare waste incinerators using extended sustainability criteria and multi-criteria analysis methods. *Environment, Development and Sustainability*, 1-31. https://doi.org/10.1007/s10668-021-01902-2

Puška, A., Štilić, A., Pamučar, D., Božanić, D., & Nedeljković, M. (2024). Introducing a Novel multi-criteria Ranking of Alternatives with Weights of Criterion (RAWEC) model. *MethodsX*, 102628. https://doi.org/10.1016/j.mex.2024.102628

Rao, S. H., Kalvakolanu, S., & Chakraborty, C. (2021). Integration of ARAS and MOORA MCDM techniques for measuring the performance of private sector banks in India. *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems*, *29*(2), 279-295. https://doi.org/10.1142/S0218488521400158

Rawan, A. (2019). Evaluating banks financial performance using financial ratios: A case study of Kuwait local commercial banks. *Oradea Journal of Business and Economics*, *4*(2), 56-68. https://doi.org/10.47535/1991ojbe078

Rebai, S., Azaiez, M. N., & Saidane, D. (2016). A multi-attribute utility model for generating a sustainability index in the banking sector. *Journal of Cleaner Production*, (113), 835-849. https://doi.org/10.1016/j.jclepro.2015.10.129

Ren, X., Zeng, G., & Zhao, Y. (2023). Digital finance and corporate ESG performance: Empirical evidence from listed companies in China. *Pacific-Basin Finance Journal*, (79), 102019. https://doi.org/10.1016/j.pacfin.2023.102019

Ruberti, M. (2023). The chip manufacturing industry: Environmental impacts and eco-efficiency analysis. *Science of the Total Environment*, (858), 159873. https://doi.org/10.1016/j.scitotenv.2022.159873

Sama, H. R., Kosuri, S. V. K., & Kalvakolanu, S. (2022). Evaluating and ranking the Indian private sector banks-a multi-criteria decision-making approach. *Journal Of Public Affairs*, *22*(2), E2419. https://doi.org/10.1002/pa.2419

Seçme, N. Y., Bayrakdaroğlu, A., & Kahraman, C. (2009). Fuzzy performance evaluation in Turkish banking sector using Analytic Hierarchy Process and TOPSIS. *Expert Systems with Applications, 36*(9), 11699-11709. https://doi.org/10.1016/j.eswa.2009.03.013

Shabir, M., Jiang, P., Bakhsh, S., & Zhao, Z. (2021). Economic policy uncertainty and bank stability: Threshold effect of institutional quality and competition. *Pacific-Basin Finance Journal*, (68), 101610. https://doi.org/10.1016/j.pacfin.2021.101610

Shabir, M., Jiang, P., Wang, W., & Işık, Ö. (2023). COVID-19 pandemic impact on banking sector: A cross-country analysis. *Journal of Multinational Financial Management*, (67), 100784. https://doi.org/10.1016/j.mulfin.2023.100784

Shabir, M., Jiang, P., Shahab, Y., Wang, W., Işık, Ö., & Mehroush, I. (2024a). Diversification and bank stability: Role of political instability and climate risk. *International Review of Economics & Finance*, (89), 63-92. https://doi.org/10.1016/j.iref.2023.10.009

Shabir, M., Ping, J., Işik, Ö., & Razzaq, K. (2024b). Impact of corporate social responsibility on bank performance in emerging markets. *International Journal of Emerging Markets*. https://doi.org/10.1108/IJOEM-02-2023-0208

Siew, L. W., Fai, L. K. & Hoe, L. W. (2017). Evaluation on the financial performance of the Malaysian banks with TOPSIS model. *American Journal of Service Science and Management*, *4*(2), 11-16.

Singareddy, R. R. R., Chandrasekaran, S., Annamalai, B. & Ranjan, P. (2023). Corporate governance data of 6 Asian economies (2010–2017). *Data in Brief*, (20), 53–56. https://doi.org/10.1016/j.dib.2018.07.048

Sobhani, F. A., Amran, A., & Zainuddin, Y. (2012). Sustainability disclosure in annual reports and websites: A study of the banking industry in Bangladesh. *Journal of Cleaner Production*, *23*(1), 75-85. https://doi.org/10.1016/j.jclepro.2011.09.023

Stauropoulou A, Sardianou E. (2019). Understanding and measuring sustainability performance in the banking sector. *IOP Conference Series: Earth and Environmental Science*, (362), 012128.

Stević, Ž., Pamučar, D., Puška, A., & Chatterjee, P. (2020). Sustainable supplier selection in healthcare industries using a new MCDM method: Measurement of Alternatives and Ranking According to COmpromise Solution (MARCOS). *Computers & Industrial Engineering*, (140), 106231. https://doi.org/10.1016/j.cie.2019.106231

Tan, M. V. & Valdez, J. T. (2023). Leveraging electronic device outputs for service quality assessment of public transportation systems: An initial look at the Philippines' service contracting program through data analytic lens. *Transportation Research Interdisciplinary Perspectives* (22), 100963. https://doi.org/10.1016/j.trip.2023.100963

Terzioğlu, M. K., Temelli, S., Yaşar, A., & Özdemir, Ö. (2023). Bankacılık sektöründe finansal ve çevresel performansların çok kriterli karar verme yöntemleri ile karşılaştırılması. *Karadeniz Teknik Üniversitesi Sosyal Bilimler Enstitüsü Sosyal Bilimler Dergisi, 13*(25), 21-45.

Ullmann, A.A. (1985). Data in search of a theory: a critical examination of the relationships among social performance, social disclosure, and economic performance of US firms, *The Academy of Management Review*, *10*(3), 540-557. https://doi.org/10.5465/amr.1985.4278989

Umar, U. H., Abduh, M., & Besar, M. H. A. (2023). Audit committee attributes and Islamic bank risk-taking behavior. *Journal of Islamic Accounting and Business Research*, *14*(6), 868-886.

Wang, Z., Wang, Z., & Su, X. (2020). Are banks misled by leverage misestimate of Chinese listed companies? *Nankai Business Review International*, *11*(4), 507-535.

Wanke, P., Azad, A. K. and Emrouznejad, A. (2018). Efficiency in BRICS banking under data vagueness: A two-stage fuzzy approach. *Global Finance Journal*, (35), 58-71. https://doi.org/10.1016/j.gfj.2017.05.001

Wei, L., Feng, X., Liu, P., & Wang, N. (2023). Impact of intelligence on the carbon emissions of energy consumption in the mining industry based on the expanded STIRPAT model. *Ore Geology Reviews*, 105504. https://doi.org/10.1016/j.oregeorev.2023.105504

Wu, J., Wang, D., Fu, X., & Meng, W. (2023). Antecedent configurations of ESG disclosure: evidence from the banking sector in China. *Sustainability*, *15*(17), 13234. https://doi.org/10.3390/su151713234

Wu, M.W. and Shen, C.H. (2013). Corporate social responsibility in the banking industry: Motives and financial performance. *Journal of Banking and Finance*, *37*(9), 3529-3547. https://doi.org/10.1016/j.jbankfin.2013.04.023

Wulandari, S., & Barokah, Z. (2023). Determinants of audit report lag: Evidence from commercial banks in Indonesia. *The Indonesian Journal of Accounting Research*, *25*(3), 413-436

Xiazi, X., & Shabir, M. (2022). Coronavirus pandemic impact on bank performance. *Frontiers in Psychology*, (13), 1014009. https://doi.org/10.3389/fpsyg.2022.1014009

Yamaltdinova, A. (2017). Kırgızistan bankalarının finansal performanslarının TOPSIS yöntemiyle değerlendirilmesi. *International Review of Economics and Management*, *5*(2), 68-87. https://doi.org/10.18825/iremjournal.316694

Yıldırım, H. ve Yaman, B. O. (2023). Türk bankacılık sektöründe 2018-2022 dönemi sürdürülebilirlik performanslarının ENTROPI, TOPSIS ve ARAS yöntemleri ile analizi. *Ardahan Üniversitesi İİBF Dergisi*, *5*(1), 39-48. http://doi.org/10.58588/aru-jfeas.1282893

Zahid, M., Rahman, H. U., Ullah, Z., & Muhammad, A. (2021). Sustainability and branchless banking: The development and validation of a distinct measurement scale. *Technology in Society*, (67), 101764. https://doi.org/10.1016/j.techsoc.2021.10176

Zakaria, Z., & Purhanudin, N. (2017). Bank risks and total productivity changes in Malaysian banks. *International Journal of Business Management and Economic Research (IJBMER)*, *8*(2), 894-901.

Zarafat, H., & Prabhune, P. A. (2018). Analysing the determinants of total risk in Basel III transition era: Evidence from Indian public and private sector banks. *Asian Journal of Management Sciences & Education, 7*(3), 67-77.

Zavadskas, E. K., Kaklauskas, A., & Kvederytė, N. (2001). Multivariant design and multiple criteria analysis of a building life cycle. *Informatica, 12*(1), 169-188.

Zhou, G., Sun, Y., Luo, S. and Liao, J. (2021). Corporate social responsibility and bank financial performance in China: The moderating role of green credit. *Energy Economics*, (97), 105190, https://doi.org/10.1016/j.eneco.2021.105190