Ekonomi, Politika & Finans Araştırmaları Dergisi, 2025, 10(Özel Sayı): 30-58
Journal of Research in Economics, Politics & Finance, 2025, 10(Special Issue): 30-58
Araştırma Makalesi / Research Article, https://doi.org/10.30784/epfad.1813034

SUSTAINABILITY PERFORMANCE EVALUATION MODEL OF BANKING SECTOR: AN INTUITIONISTIC FUZZY MULTI-CRITERIA APPROACH WITH A NON-HOMOGENEOUS DATA SET*

Bankacılık Sektörü Sürdürülebilirlik Performans Değerlendirme Modeli: Homojen Olmayan Veri Seti ile Sezgisel Bulanık Çok Kriterli Yaklaşım

Burcu SIMSEK YAGLI** & **Nuri Ozgur DOGAN*****

Abstract

This study aims to develop a comprehensive and multidimensional framework to assess sustainability performance in the banking sector. We propose the Banking Sector Sustainability Model (BSSM), which integrates six dimensions: social, innovation, governance, environmental, economic, and financial criteria. To determine the relative importance of these dimensions, the study employs the Interval-Valued Intuitionistic Fuzzy Best-Worst Method (IVIF-BWM). Then, banks are ranked using the Intuitionistic Fuzzy Weighted Correlation Coefficient (IF-WCC) method, allowing for comparison based on diverse and heterogeneous data. The results reveal that expert groups have different priorities, with some highlighting environmental concerns and others prioritizing economic factors, indicating the framework's potential to capture diverse stakeholder perspectives. Sensitivity analyses confirm the stability and reliability of the proposed approach. Overall, the study proposes novel and practical tool for evaluating sustainability in the banking sector. The framework can support decision-makers, financial institutions, and researchers in promoting sustainable banking and enhancing transparency and accountability in the sector.

Keywords:
Banking Sector Sustainability Model, Intuitionistic Fuzzy Sets, BWM, WCC, Heterogeneous Data.

JEL Codes:
G21, Q01, D81, C44.

Öz

Bu çalışma, bankacılık sektöründe sürdürülebilirlik performansını değerlendirmek için kapsamlı ve çok boyutlu bir çerçeve geliştirmeyi amaçlamaktadır. Çalışmada, sosyal, inovasyon, yönetişim, çevresel, ekonomik ve finansal kriterler olmak üzere altı boyutu birleştiren Bankacılık Sektörü Sürdürülebilirlik Modeli (BSSM) önerilmektedir. Bu boyutların göreli önemini belirlemek için Aralık Değerli Sezgisel Bulanık Best Worst Metodu (IVIF-BWM) kullanmaktadır. Ardından, bankalar heterojen verilere dayalı karşılaştırmaya olanak tanıyan Sezgisel Bulanık Ağırlıklı Korelasyon Katsayısı (IF-WCC) yöntemi kullanılarak sıralanmaktadır. Sonuçlar, uzman grupları arasında önceliklerde farklılıklar olduğunu göstermektedir; bazıları çevresel kaygıları vurgularken diğerleri ekonomik faktörleri önceliklendirmektedir ve bu da çerçevenin farklı paydaş bakış açılarını yakalama yeteneğini göstermektedir. Duyarlılık analizleri, önerilen yaklaşımın istikrarını ve güvenilirliğini doğrulamaktadır. Özetle çalışma, bankacılık sektöründe sürdürülebilirliği değerlendirmek için yeni ve pratik bir araç sağlamaktadır. Çerçevenin karar vericileri, finans kuruluşlarını ve araştırmacıları sürdürülebilir bankacılığa teşvik etmede ve sektörde şeffaflık ve hesap verebilirliği artırmada etkili olacağına inanılmaktadır.

Anahtar Kelimeler:
Bankacılık Sektörü Sürdürülebilirlik Modeli, Sezgisel Bulanık Kümeler, BWM, WCC, Heterojen Veri.

JEL Kodları:
G21, Q01, D81, C44.

* This research paper is derived from Burcu Simsek Yagli's PhD thesis carried out under the supervision of Prof. Dr. Nuri Ozgur Dogan.

** Dr., Department of Business Administration, Nevsehir Haci Bektas Veli University, Nevsehir, Türkiye, burcusimsek@nevsehir.edu.tr

*** Prof. Dr., Department of Health Management, Istanbul Medeniyet University, Istanbul, Türkiye, nodogan@medeniyet.edu.tr

Received Date (Makale Geliş Tarihi): 30.08.2025 *Accepted Date (Makale Kabul Tarihi): 21.10.2025*

1. Introduction

Contemporary global challenges such as climate change, the depletion of natural resources, social inequalities, and economic vulnerabilities have made sustainability an essential framework for both individuals and organizations that seeking to ensure long-term resilience and well-being. According to the Global Risks Report 2024, the most significant risks anticipated over the next decade are environmental in nature, including extreme weather events, biodiversity loss, and natural resource scarcity (World Economic Forum, 2024). This alarming outlook compels all sectors to adopt a more proactive approach toward achieving the Sustainable Development Goals (SDGs). Furthermore, growing environmental awareness, rapid technological advancements, evolving regulatory requirements, and changing consumer preferences toward eco-conscious practices increasingly necessitate the integration of sustainability-oriented strategies across both manufacturing and service industries (Barbosa and de Oliveira, 2021). In this context, the development of environmentally friendly products and services, the implementation of waste recycling programs, corporate social responsibility (CSR) initiatives, and the efficient use of resources have emerged as strategic priorities for businesses.

The growing environmental and social risks at the global level have significantly increased the sensitivity of the financial sector particularly banking toward sustainability concerns. Given its capacity to allocate financial resources, the banking sector holds a pivotal role in driving the sustainability transformation. According to the United Nations Environment Programme Finance Initiative (UNEP FI), as of 2024, more than 300 banks representing over 50% of global banking assets have committed to the Principles for Responsible Banking (UNEP FI, 2024). On a national scale, data from the Banks Association of Türkiye (TBB) show that, as of 2023, 25 out of 60 banks operating in the Turkish banking sector publish sustainability reports, while 15 explicitly declare their contributions to the SDGs (TBB, 2023).

Sustainability practices have become increasingly important in sectors such as banking, which are deeply interconnected with other industries and thus have broad systemic impacts. Sustainable banking encompasses a wide array of practices, including the implementation of environmental policies, transparency with stakeholders, and collaboration with governments and non-governmental organizations to promote sustainability (Bouma et al., 2017). Rather than being limited to economic performance alone, sustainability is understood as a holistic approach that simultaneously considers environmental, economic, and social dimensions (Kumar et al., 2018). Based on Stakeholder Theory and the Triple Bottom Line (TBL) framework, it would be appropriate to add overarching dimensions to the assessment of bank sustainability. In many cases, this approach is framed within the Environmental, Social, and Governance (ESG) model, which emphasizes the need for multi-dimensional performance evaluation to ensure the continuity and effectiveness of systems and processes (Zhou et al., 2018). Despite this growing importance, some banks are observed to adopt sustainability initiatives only in a limited manner due to concerns over costs or fail to communicate these efforts transparently to the public (Rabea'Hadi et al., 2023). Additionally, significant inconsistencies exist in the content of information disclosed through bank websites, integrated reports, and sustainability reports (TBB, 2023), making it difficult to comparatively assess the sustainability performance of banks.

When discussing sustainability in the banking industry, the studies in the literature generally focus on the CSR (Nájera-Sánchez, 2020). Furthermore, a review of recent studies on performance evaluation in the banking sector which has made significant strides toward

sustainability, reveals that the focus is predominantly on the relationship between CSR and financial performance (FP). However, comprehensive models that address the multidimensional nature of sustainability performance remain limited (see Karagiorgos, 2010; Ahmed et al., 2012; Pour et al., 2014; Kılıç et al., 2015; Ashraf et al., 2017; Weber, 2017; Wang et al., 2018; Gangi et al., 2018; Nizam, 2019; Khattak, 2021; Pala, 2022). Studies analyzing the CSR-FP relationship in the banking sector typically employ regression analysis, statistical techniques, or content analysis (Chowdhury and Paul, 2020). The findings suggest that the impact of CSR on FP can be positive, negative, or neutral (Islam et al., 2012). Nonetheless, evaluating banks' sustainability activities solely through financial metrics is insufficient.

Various institutions and organizations have developed diverse models for evaluating sustainability performance. Research in this field extends beyond practice-oriented entities and is extensively addressed within the academic literature. Specifically, performance evaluation models that capture the multidimensional nature of sustainability have been proposed. These models often employ multi-criteria decision-making (MCDM) methods and a range of quantitative analysis techniques to assign weights to performance criteria and rank alternatives such as banks. Notable studies in this area include Hassan and Harrahap (2010), Ohene-Asare and Asmild (2012), Özçelik and Öztürk (2014), Aras et al. (2016, 2017, 2018), Akın and Yılmaz (2016), Rebai et al. (2016), Raut et al. (2017), Korzeb and Samaniego-Medina (2019), Stauropoulou and Sardianou (2019), Simsek Yagli et al. (2022), Ecer and Pamucar (2022), Nepomuceno et al. (2024), and Sharma and Kumar (2024). However, challenges related to limited data availability and insufficient transparency in some banks' sustainability disclosures hinder the accuracy and comparability of performance analyses. In this context, intuitionistic fuzzy logic-based MCDM methods have gained importance as they effectively handle linguistic and uncertain data. As a systematic approach to analyzing complex, multidimensional decision problems, MCDM proves particularly useful for addressing sustainability evaluation.

Additionally, Aracil et al. (2021) emphasize that sustainability evaluations in the banking sector often focus on specific aspects and lack a comprehensive, multidimensional assessment. Therefore, there is a clear need for a methodological framework that offers a practical and comprehensible solution by integrating multiple dimensions to evaluate sustainability performance in banking. Current literature addressing this need remains limited. Moreover, evaluation outcomes can vary significantly depending on different stakeholder perspectives, highlighting the importance of examining and comparing the views of diverse groups to promote a sustainable banking sector (Nájera-Sánchez, 2020). Addressing these identified gaps, this study aims to propose an intuitionistic fuzzy set-based, multi-criteria, and practical methodological framework for assessing sustainability performance in the banking sector. Within this scope, a Banking Sector Sustainability Model (BSSM) is first developed; subsequently, the criteria weights are determined using the Interval-Valued Intuitionistic Fuzzy Best-Worst Method (IVIF-BWM), and banks are ranked via the Weighted Correlation Coefficient (WCC) method. This approach facilitates a multidimensional and comparative evaluation mechanism tailored specifically to the banking sector. The current study seeks to achieve the following research objectives: (i) identifying the key sustainability dimensions relevant to the banking sector, (ii) determining their relative importance through expert evaluations, and comparing the results and (iii) applying the proposed multi-criteria approach to derive a robust and comparable ranking of banks. This research therefore bridges the gap between theoretical sustainability concepts and their practical operationalization within the sustainability of banking sector.

2. Banking Sector Sustainability Model (BSSM)

Ehrenfeld (2008) emphasized that sustainability should not merely be managed, but also systematically measured and evaluated. For businesses to operate sustainably, it is crucial to implement an effective performance measurement system capable of assessing sustainability outcomes. In this context, organizations increasingly seek models that facilitate objective, user-friendly evaluation and enable benchmarking against competitors.

The theoretical foundation of the proposed BSSM is grounded mainly in Stakeholder Theory (Freeman and McVea, 2005) and the TBL framework (Elkington, 1997), which emphasize that sustainable performance cannot be captured solely through financial metrics. In the banking sector, sustainability emerges as a multidimensional construct encompassing economic, social, and environmental responsibilities toward diverse stakeholders. Although the three dimensions of the TBL approach appear to align with stakeholder theory, they do not fully address the varying expectations of stakeholders. Therefore, a more comprehensive framework based on relevant theories is required.

Existing sustainability frameworks such as the TBL, Global Reporting Initiative (GRI), Dow Jones Sustainability Index (DJSI), and the ESG criteria typically address economic, social, and environmental dimensions and serve as foundational tools for sector or region-specific performance assessments. However, these models alone are often insufficient for conducting comprehensive evaluations at the sectoral or regional level. For instance, while GRI primarily functions as a reporting standard rather than a performance evaluation tool, TBL, despite its widespread acceptance, requires customization to reflect sector-specific dynamics. Similarly, other frameworks necessitate adaptation to the contextual needs of particular industries.

Recent studies highlight an increasing emphasis on environmental aspects in sustainability performance assessments, alongside the integrated evaluation of economic, social, and environmental pillars (Morioka and de Carvalho, 2016). However, significant challenges remain in managing, measuring, and reporting sustainability comprehensively and consistently (Aras et al., 2018). Traditional frameworks such as TBL, GRI, DJSI, and ESG provide a foundation but often fall short in capturing sector-specific complexities, particularly in banking. Financial institutions, especially banks, play a critical role in sustainable development, and growing stakeholder pressure necessitates more robust, transparent, and objective sustainability performance models (Stauropoulou and Sardianou, 2019). To address contemporary challenges such as digital transformation and governance transparency, the BSSM extends the classical TBL framework by incorporating innovation, governance, and financial dimensions, aligning with the principles of Institutional Theory (DiMaggio and Powell, 1983) and the Dynamic Capabilities perspective (Teece, 2018). Thus, the dimensions reflect both normative expectations and strategic capabilities that jointly determine sustainable banking performance. In response to these gaps, this study introduces the BSSM that is a novel decision support tool developed through literature review and expert consultation (Figure 1).

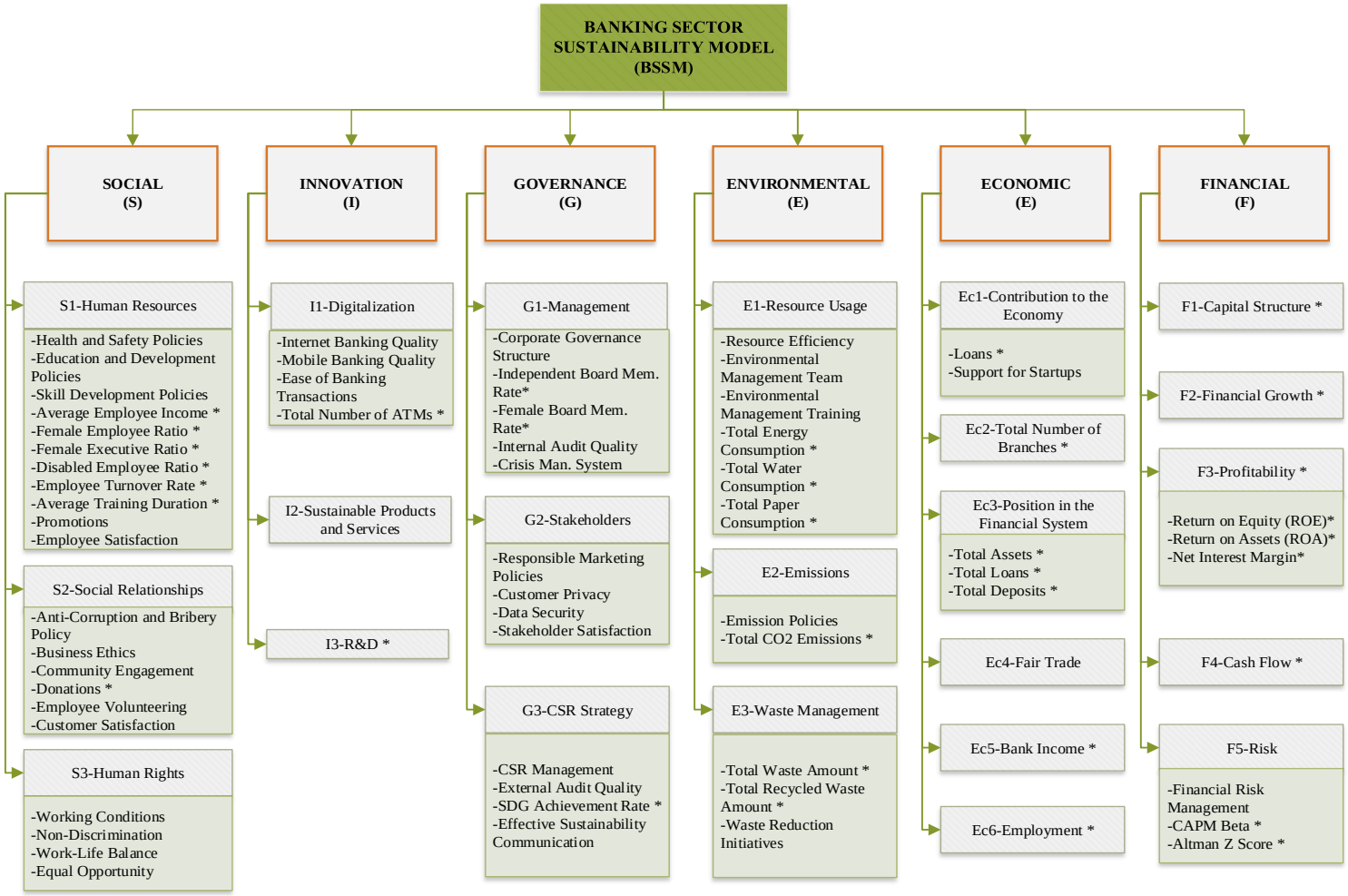


Figure 1. Banking Sector Sustainability Model (BSSM)

While drawing on established frameworks (TBL, GRI, ESG, DJSI, BIST Sustainability Index, UN SDGs, and ISO 26000), the BSSM extends beyond existing models in several ways. First, it incorporates Innovation as a sixth core dimension, alongside Social, Environmental, Governance, Economic, and Financial, reflecting the growing relevance of digitalization in banking. It reflects the sector's adaptive capacity and long-term competitiveness. Second, it integrates both qualitative and quantitative data types, increasing flexibility and real-world applicability. Unlike many existing models based on homogeneous data sets, BSSM incorporates both quantitative data (interval or crisp values) and qualitative data, denoted by an asterisk (*) in Figure 1. Third, it is structured as a multi-criteria, multi-level model (SIGEEF), comprising 6 main criteria, 23 sub-criteria, and 60 third-level indicators, all tailored specifically for the banking sector. In summary, the theoretical structure of the BSSM integrates normative principles (Stakeholder theory and TBL frameworks) with institutional and strategic perspectives (Institutional and Dynamic Capabilities theories). Therefore, the BSSM offers a comprehensive, adaptable, and stakeholder-friendly framework for evaluating sustainability performance. Its development is rooted in both academic foundations and practical relevance, and as detailed in Appendix 1, it uniquely synthesizes and contextualizes a wide range of global and national standards.

3. Methodology

To address the study's research objectives, a structured methodological framework was developed based on the BSSM model, incorporating both primary and secondary data. Given the model's multidimensional nature, MCDM techniques were employed. To account for the uncertainty and subjectivity inherent in expert evaluations, intuitionistic fuzzy sets were utilized. The BWM was applied to determine the weights of the criteria, while the WCC method was used to rank the banks according to their sustainability performance. The following sections provide a detailed explanation of each methodological steps.

3.1. Multi-Criteria Decision Making

Decision-making is a fundamental aspect of both individual and organizational life. Real-world problems often involve multiple data types, ranging from precise and objective to subjective and uncertain (Belton and Stewart, 2002). As most decision problems are inherently multi-criteria in nature, MCDM provides an effective framework for analyzing complex issues and achieving balanced, optimal solutions (Amor et al., 2020). As a result, MCDM has become a prominent research area within decision theory (Mi et al., 2019).

MCDM methods offer structured approaches for evaluating complex decisions by helping decision-makers compare alternatives across various criteria (Wang et al., 2017). These techniques support holistic analyses and informed choices without neglecting critical details (Carayannis et al., 2018). A wide range of MCDM methods has been developed for tasks such as criteria weighting, prioritization, and alternative ranking. However, no single, universally accepted MCDM methodology exists, as methods differ in assumptions, complexity, and computational procedures. A common criticism is that different MCDM techniques can produce varying results for the same problem (El Amine et al., 2014). Thus, selecting the most appropriate

method requires a clear understanding of their respective strengths and limitations (Çelikbilek and Tüysüz, 2020).

Since the 1950s, MCDM has been widely applied in both managerial practice and academic research. Its key application areas include corporate sustainability (Chowdhury and Paul, 2020), financial performance (Abdel-Basset et al., 2020), logistics (Chejarla et al., 2022), human resources (Esangbedo et al., 2021), energy policy (Kaya et al., 2018), location selection (Shao et al., 2020), and tourism (Vatankhah et al., 2023).

3.2. Interval Valued Intuitionistic Fuzzy Sets

Intuitionistic fuzzy sets (IFSs) consider membership and non-membership functions along with hesitation degrees. However, interval-valued intuitionistic fuzzy sets (IVIFSs) advance beyond IFSs by handling membership and non-membership functions as intervals, making them more effective in managing uncertainty. This provides advantages in modeling and solving more complex problems. The fundamental definitions of IVIFSs are introduced in the studies by Onar et al. (2015) and Karaşan et al. (2020).

3.3. IVIF Best Worst Method

The BWM was first developed by Rezaei (2015). It is a recent technique that excels in reducing the number of pairwise comparisons while maintaining consistency among judgments. Unlike other weighting methods, BWM requires comparisons only between the best (most important or most desired) criterion and all other criteria, as well as between all criteria and the worst (least important or least desired) criterion. Compared to other methods, BWM is simpler, more accurate, and eliminates unnecessary (redundant) comparisons (Pamučar et al., 2020). The method aims to determine optimal weights and ensure the consistency of matrices through a simple optimization model constructed from the comparison process (Rezaei et al., 2016).

The five steps of the IVIF-BWM algorithm are listed below (Wang et al., 2021; Mohammadi et al., 2022; Simsek Yagli et al., 2022):

Step 1. From the decision-makers' perspective, the most important (or best - C_B) criterion and the least important (or worst - C_W) criterion are identified from a predefined set of criteria (C_j, $j=1,2,\ldots,n$).

Step 2. Using a linguistic scale, the most important criterion is compared to all other criteria by each decision-maker (DM_k) (Best-to-Others vector).

$$\tilde{R}_B^{(k)} = (\tilde{r}_{B1}^{(k)}, \tilde{r}_{B2}^{(k)}, \ldots, \tilde{r}_{Bn}^{(k)}) \quad (1)$$

Here, $\tilde{r}_{Bj}^{(k)} = \left(\left[\tilde{\mu}_{Bj}^{(L)}, \tilde{\mu}_{Bj}^{(U)}\right], \left[\tilde{v}_{Bj}^{(L)}, \tilde{v}_{Bj}^{(U)}\right]\right)$ represents the IVIF preference of the most important criterion (C_B) over the other criteria C_j as expressed by each decision-maker DM_k.

Step 3. Using a linguistic scale, each kth decision-maker (DM_k) compares the other criteria to the least important criterion (C_W), forming the Others-to-Worst vector.

$$\tilde{R}_W^{(k)} = (\tilde{r}_{1W}^{(k)}, \tilde{r}_{2W}^{(k)}, \ldots, \tilde{r}_{nW}^{(k)}) \quad (2)$$

Here, $\tilde{r}_{jW}^{(k)} = \left(\left[\tilde{\mu}_{jW}^{(L)}, \tilde{\mu}_{jW}^{(U)}\right], \left[\tilde{v}_{jW}^{(L)}, \tilde{v}_{jW}^{(U)}\right]\right)$ represents the IVIF preference of each criterion *Cj* relative to the least important criterion (C_W), as expressed by each decision-maker DM_k.

Step 4. The optimal weights are calculated for each decision-maker DM_k.

Here, it is assumed that: $\tilde{\omega}_B^{(k)} = \left(\left[\tilde{\mu}_B^{(L)}, \tilde{\mu}_B^{(U)}\right], \left[\tilde{v}_B^{(L)}, \tilde{v}_B^{(U)}\right]\right)$, $\tilde{\omega}_W^{(k)} = \left(\left[\tilde{\mu}_W^{(L)}, \tilde{\mu}_W^{(U)}\right], \left[\tilde{v}_W^{(L)}, \tilde{v}_W^{(U)}\right]\right)$ and $\tilde{\omega}_j^{(k)} = \left(\left[\tilde{\mu}_j^{(L)}, \tilde{\mu}_j^{(U)}\right], \left[\tilde{v}_j^{(L)}, \tilde{v}_j^{(U)}\right]\right)$ represent the IVIF weights of the best, worst, and jth criteria, respectively, as determined by decision maker DM_k. The optimal weight for each criterion is derived based on minimizing the maximum absolute deviations between the calculated ratios and the corresponding IVIF preferences: $\left|\frac{\tilde{\omega}_B^{(k)}}{\tilde{\omega}_j^{(k)}} - \tilde{r}_{Bj}^{(k)}\right|$ and $\left|\frac{\tilde{\omega}_j^{(k)}}{\tilde{\omega}_W^{(k)}} - \tilde{r}_{jW}^{(k)}\right|$. A solution is then obtained that minimizes these maximum absolute deviations for all criteria Cj, ensuring that the optimal weights satisfy the preferences provided by the decision maker. Additionally, taking into account that the weights must be non-negative and their sum must equal to 1, the following optimization model (Model 1) is solved to obtain the optimal criterion weights for each decision maker DM_k. Model 1:

$min\varepsilon$

St.

$\left|\mu_B^{L(k)} + v_j^{L(k)} - \mu_B^{L(k)}.v_j^{L(k)} - \mu_{Bj}^{L(k)}\right| \leq \varepsilon$, for all C_j criteria

$\left|\mu_B^{U(k)} + v_j^{U(k)} - \mu_B^{U(k)}.v_j^{U(k)} - \mu_{Bj}^{U(k)}\right| \leq \varepsilon$, for all C_j criteria

$\left|v_B^{L(k)} + \mu_j^{L(k)} - v_{Bj}^{L(k)}\right| \leq \varepsilon$, for all C_j criteria

$\left|v_B^{U(k)} + \mu_j^{U(k)} - v_{Bj}^{U(k)}\right| \leq \varepsilon$, for all C_j criteria

$\left|\mu_j^{L(k)} + v_W^{L(k)} - \mu_j^{L(k)}.v_W^{L(k)} - \mu_{jW}^{L(k)}\right| \leq \varepsilon$, for all C_j criteria

$\left|\mu_j^{U(k)} + v_W^{U(k)} - \mu_j^{U(k)}.v_W^{U(k)} - \mu_{jW}^{U(k)}\right| \leq \varepsilon$, for all C_j criteria

$\left|v_j^{L(k)} + \mu_W^{L(k)} - v_{jW}^{L(k)}\right| \leq \varepsilon$, for all C_j criteria

$\left|v_j^{U(k)} + \mu_W^{U(k)} - v_{jW}^{U(k)}\right| \leq \varepsilon$, for all C_j criteria

$\sum_{j=1}^{n} S\left(\tilde{\omega}_j^{(k)}\right) = 1$

$S\left(\tilde{\omega}_j^{(k)}\right) \geq 0$, for all C_j criteria

By solving Model 1 above, the optimal weights of each criterion for decision maker DM_k, denoted as ε* and $\tilde{\omega}^{(k)} = (\tilde{\omega}_1, \tilde{\omega}_2, \ldots, \tilde{\omega}_n)^{(k)}$ are obtained. Here, ε* is defined as the consistency ratio of the comparison system, and a value close to zero indicates that the comparisons made by DM_k are highly consistent (Rezaei et al., 2016).

Step 5. Each criterion's optimal weight is defuzzified. Given that $\tilde{\omega}_j = ([a, b], [c, d])$

$$\omega_j = \frac{a + a(1 - a - c) + b + b(1 - b - d)}{2} \tag{3}$$

3.4. Weighted Correlation Coefficient

Numerous MCDM methods have been developed to evaluate and rank alternatives based on predefined criteria. In this study, the WCC method proposed by Ye (2010) is employed. This

approach ranks alternatives by calculating the weighted correlation between each alternative and an ideal solution, thereby facilitating the identification of the most suitable option.

Let $X = \{x_1, x_2, \dots, x_n\}$ be a finite universe, and consider $A = \{< x_i, \mu_A(x_i), v_A(x_i) > x_i \in X\}$ and $B = \{< x_i, \mu_B(x_i), v_B(x_i) > x_i \in X\}$ as two intuitionistic fuzzy numbers (IFNs). The correlation coefficient between *A* and *B* is given by Equation 4 (Gerstenkorn and Mańko, 1991).

$$k(A,B) = \frac{C(A,B)}{\sqrt{T(A)\,.\,T(B)}} \tag{4}$$

Here, $(A,B) = \sum_{i=1}^{n}\left(\mu_A(x_i)\,\mu_B(x_i) + v_A(x_i)v_B(x_i)\right)$, $T(A) = \sum_{i=1}^{n}\left(\mu_A^2(x_i) + v_A^2(x_i)\right)$ and $T(B) = \sum_{i=1}^{n}\left(\mu_B^2(x_i) + v_B^2(x_i)\right)$.

The correlation coefficient between two intuitionistic fuzzy sets (IFS) A and B should satisfy the following properties (Ye, 2010): (i) $0 \le k(A,B) \le 1$, (ii) $k(A,B) = k(B,A)$, (iii) $k(A,B) = 1\ if\ and\ only\ if\ A = B$. Then, the obtained criterion weights ($w_j = w_1, w_2, \dots, w_n$) are used in the formula in Equation 5 to calculate the WCC between alternative A_i and the ideal alternative A^*.

$$W_i(A^*, A_i) = \frac{C_i(A^*, A_i)}{\sqrt{T^*(A^*)\,.\,T_i(A_i)}} = \frac{\sum_{j=1}^{n} w_j \mu_{A_i}(C_j)}{\sqrt{\sum_{j=1}^{n} w_j \left({\mu_{A_i}}^2(C_j) + {v_{A_i}}^2(C_j)\right)}} \tag{5}$$

The larger the value of the weighted correlation coefficient W_i, the closer the alternative A_i is to the ideal alternative A^*, and therefore, the better the alternative A_i is. Consequently, all alternatives can be ranked according to their weighted correlation coefficients, allowing the best alternative to be selected.

The weighted correlation coefficient W_i between A^* and A_i (for *i=1,2,…,m*) should satisfy the following properties: (i) $0 \le W_i(A^*, A_i) \le 1$, (ii) $W_i(A^*, A_i) = W_i(A_i, A^*)$, (iii) $W_i(A^*, A_i) = 1\ if\ and\ only\ if\ A^* = A_i$.

4. Applications and Findings

Undoubtedly, each sector has its own sustainability priorities, necessitating sector-specific and applicable evaluation models. To address the absence of such a framework in the banking sector, this study proposes the BSSM, designed to assess sustainability performance using both qualitative and quantitative data tailored to the banking context. Expert feedback confirmed the model's suitability while also emphasizing that not all criteria carry equal importance. Therefore, MCDM techniques were employed to assign weights reflecting the relative significance of each criterion.

The overall research framework, which illustrates the research objectives in detail, is outlined in Figure 2. Given the hierarchical and multidimensional structure of BSSM, traditional MCDM methods may fall short in addressing the uncertainty in expert judgments. To overcome this, the study integrates IVIF sets with the BWM, a practical and efficient weighting approach that accommodates imprecise expert evaluations (Büyüközkan et al., 2020). The aim is to enable experts to determine the relative importance of BSSM criteria, thereby guiding bank managers in resource allocation and enhancing strategic decision-making. This approach contributes a novel

methodological framework to the sustainability performance literature. Due to the difficulty in accessing comprehensive data for all 60 sub-criteria, four banks were selected and anonymized as Bank 1 through Bank 4. After expert validation of BSSM, the WCC method was adopted to rank banks based on sustainability performance. The WCC method is particularly suitable for handling heterogeneous data structures (Cavallaro et al., 2018). The final stage involved data collection to implement the weighting and ranking procedures in line with the study's objectives.

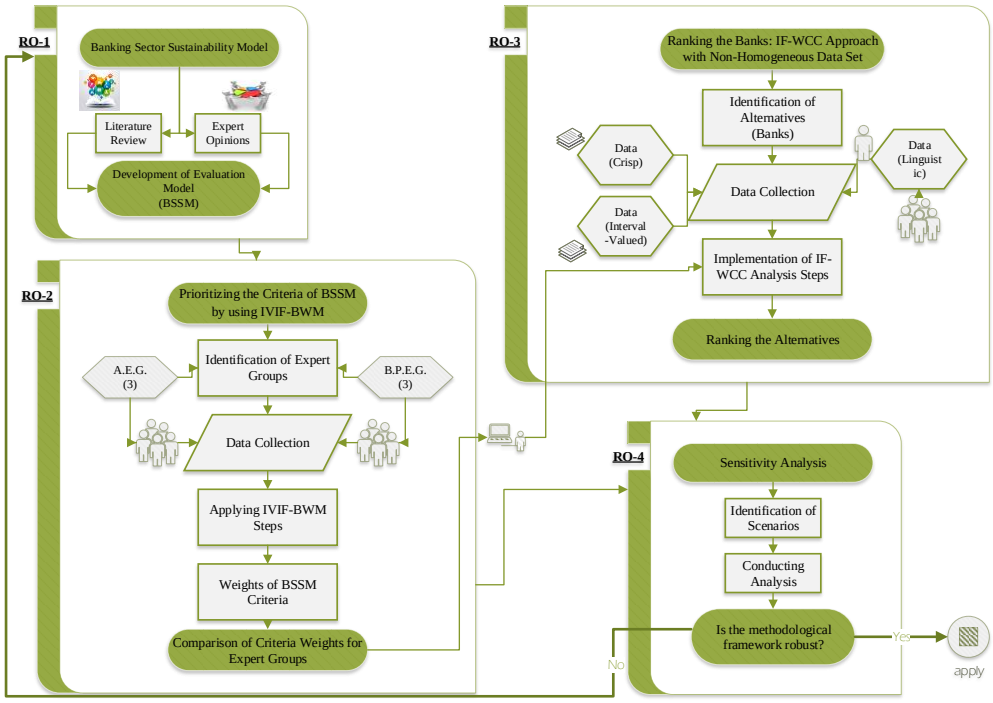


Figure 2. Research Framework

4.1. Prioritizing the Criteria of BSSM by Using IVIF-BWM

Based on literature reviews and expert opinions, it was concluded that the criteria within the proposed BSSM vary in importance and do not carry equal weights. To capture diverse perspectives, consultations were conducted with two expert groups, three academics (A.E.G.) and three banking professionals (B.P.E.G.), revealing notable differences between these groups. To handle the uncertainty in their linguistic assessments, the IVIF-BWM was employed. The study was conducted in accordance with research and publication ethics, with approval obtained from the Nevşehir Hacı Bektaş Veli University Ethics Committee (09/08/2022, 08, 261). The expert panel included four males and two females with 8 to 16 years of professional experience and educational backgrounds ranging from bachelor's to doctoral degrees. The experts provided linguistic evaluations through consensus reached in brainstorming sessions. They were asked questions such as, "*Which criterion is most important and which is least important for evaluating a bank's sustainability performance?*" Following consensus, they rated the most important criterion against others, and the remaining criteria relative to the least important, using linguistic terms outlined in Table 1.

Table 1. Linguistic Scale for Pairwise Comparisons

Linguistic Term	IVIF Number Equivalent
Equally Important (EI)	([1.0,1.0],[0.0,0.0])
Weakly Important (WI)	([0.5,0.6],[0.3,0.4])
Strongly Important (SM)	([0.6,0.7],[0.2,0.3])
Very Important (VI)	([0.7,0.8],[0.1,0.2])
Absolutely Important (AI)	([0.8,0.9],[0.1,0.2])

Source: Wang et al., 2021.

Subsequently, pairwise comparison questionnaires were completed using linguistic terms derived through a brainstorming approach by A.E.G. These linguistic assessments were then translated into IVIF numbers based on the scale provided in Table 1. To determine the optimal weights of the BSSM criteria from the perspective of the academic expert group, the collected data were processed accordingly. Utilizing Model 1 as a foundation, a corresponding model was developed for the main criteria set. In a similar manner, separate models were formulated for each set of main and sub-criteria.

```
min=z;
@abs(x4L+y1L-x4L*y1L-0.6)<=z; @abs(x4U+y1U-x4U*y1U-0.7)<=z; @abs(y4L+x1L-0.2)<=z;
@abs(y4U+x1U-0.3)<=z; @abs(x4L+y2L-x4L*y2L-0.6)<=z; @abs(x4U+y2U-x4U*y2U-0.7)<=z;
@abs(y4L+x2L-0.2)<=z; @abs(y4U+x2U-0.3)<=z; @abs(x4L+y3L-x4L*y3L-0.7)<=z; @abs(x4U+y3U-
x4U*y3U-0.8)<=z; @abs(y4L+x3L-0.1)<=z; @abs(y4U+x3U-0.2)<=z; @abs(x4L+y5L-x4L*y5L-
0.6)<=z; @abs(x4U+y5U-x4U*y5U-0.7)<=z; @abs(y4L+x5L-0.2)<=z; @abs(y4U+x5U-0.3)<=z;
@abs(x4L+y6L-x4L*y6L-0.5)<=z; @abs(x4U+y6U-x4U*y6U-0.6)<=z; @abs(y4L+x6L-0.3)<=z;
@abs(y4U+x6U-0.4)<=z; @abs(x1L+y3L-x1L*y3L-0.5)<=z; @abs(x1U+y3U-x1U*y3U-0.6)<=z;
@abs(y1L+x3L-0.3)<=z; @abs(y1U+x3U-0.4)<=z; @abs(x2L+y3L-x2L*y3L-0.5)<=z; @abs(x2U+y3U-
x2U*y3U-0.6)<=z; @abs(y2L+x3L-0.3)<=z; @abs(y2U+x3U-0.4)<=z; @abs(x4L+y3L-x4L*y3L-
0.7)<=z; @abs(x4U+y3U-x4U*y3U-0.8)<=z; @abs(y4L+x3L-0.1)<=z; @abs(y4U+x3U-0.2)<=z;
@abs(x5L+y3L-x5L*y3L-0.5)<=z; @abs(x5U+y3U-x5U*y3U-0.6)<=z; @abs(y5L+x3L-0.3)<=z;
@abs(y5U+x3U-0.4)<=z; @abs(x6L+y3L-x6L*y3L-0.6)<=z; @abs(x6U+y3U-x6U*y3U-0.7)<=z;
@abs(y6L+x3L-0.2)<=z; @abs(y6U+x3U-0.3)<=z; x1L+x1U-y1L-y1U>0; x1L+x1U-y1L-y1U<2;
x2L+x2U-y2L-y2U>0; x2L+x2U-y2L-y2U<2; x3L+x3U-y3L-y3U>0; x3L+x3U-y3L-y3U<2; x4L+x4U-
y4L-y4U>0; x4L+x4U-y4L-y4U<2; x5L+x5U-y5L-y5U>0; x5L+x5U-y5L-y5U<2; x6L+x6U-y6L-
y6U>0; x6L+x6U-y6L-y6U<2; (x1L+x1U-y1L-y1U)+(x2L+x2U-y2L-y2U)+(x3L+x3U-y3L-
y3U)+(x4L+x4U-y4L-y4U)+(x5L+x5U-y5L-y5U)+(x6L+x6U-y6L-y6U)=2; x1U+y1U<=1;
x2U+y2U<=1; x3U+y3U<=1;
x4U+y4U<=1; x5U+y5U<=1; x6U+y6U<=1; x1L<x1U; y1L<y1U; x2L<x2U; y2L<y2U; x3L<x3U;
y3L<y3U; x4L<x4U; y4L<y4U; x5L<x5U; y5L<y5U; x6L<x6U; y6L<y6U;
end
```

The models were solved using the Lingo 19.0 software package, which also facilitated the computation of IVIF values. To assess the consistency of the pairwise comparisons, the BWM-Solver was employed. The consistency ratios for all comparisons were found to be within acceptable thresholds, indicating that the decision-makers provided coherent and reliable evaluations. As an illustration, the results obtained from Lingo 19.0 for the main criteria set (SIGEEF) are presented below:

$$\tilde{\omega}_S = ([0.2821,0.3026],[0.2000,0.2598])$$
$$\tilde{\omega}_I = ([0.2821,0.3026],[0.2000,0.2598])$$
$$\tilde{\omega}_G = ([0.2015,0.2417],[0.1622,0.2809])$$
$$\tilde{\omega}_E = ([0.5208,0.5808],[0.0000,0.0598])$$
$$\tilde{\omega}_{Ec} = ([0.2821,0.3026],[0.2000,0.2598])$$
$$\tilde{\omega}_F = ([0.4015,0.4417],[0.1000,0.1598])$$

Using the defuzzified criterion weights, summary findings consisting of local and global weights were obtained. Local weights represent the weight and ranking of a criterion within its own criterion set, while global weights reflect the holistic and overall importance of the lowest-level criteria. From the A.E.G. perspective, the importance ranking of the main criteria is as follows: ***Environmental (E) (0.2576) > Financial (F) (0.2014) > Social (S) (0.1426) = Innovation (I) (0.1426) = Economic (E) (0.1426) > Governance (G) (0.1134)***. Thus, when examining local weights, the A.E.G. considers the environmental factor as the most important and governance as the least important factor in a bank's sustainability. Furthermore, the ranking of the sub-criteria under the Environmental main criterion according to their importance weights is: *Resource Use (E1) (0.4582) > Waste Management (E3) (0.3507) > Emissions (E2) (0.1912)*. Similarly, for the Social main criterion, the ranking of its sub-criteria is: *Human Rights (S3) (0.4582) > Human Resources (S1) (0.3507) > Social Relations (S2) (0.1912)*. Global weights were also calculated. The criteria with the least importance include Health and Safety Policies, Talent Development Policies, Disabled Employee Ratio, Average Training Duration, Corruption and Bribery Policies, Business Ethics, Employee Volunteering, and External Audit Quality. Criteria with high importance levels include Non-Discrimination, Ease of Banking Transactions, Sustainable Products and Services, Resource Efficiency, Emission Policies, Total CO2 Emission, Waste Recycling Rate, Bank Income, Capital Structure, Financial Growth, and Net Interest Margin. The criteria identified with the highest importance weights are R&D, Total Waste Amount, and Cash Flow.

All the criterion weighting steps carried out for the A.E.G. were also conducted for the B.P.E.G. From the perspective of the bank professionals, the importance ranking of the main criteria is as follows: ***Economic (E) (0.2449) > Environmental (E) (0.1904) = Social (S) (0.1904) > Innovation (I) (0.1337) = Governance (G) (0.1337) > Financial (F) (0.1069)***. Thus, when examining the local weights, the B.P.E.G. considers the economic factor as the most important and the financial factor as the least important for a bank's sustainability. Moreover, the ranking of the sub-criteria under the Economic main criterion according to their importance weights is: *Employment (Ec6) (0.2647) > Contribution to the Economy (Ec1) (0.2239) > Fair Trade (Ec4) (0.1605) > Bank Income (Ec5) (0.1251) > Total Number of Branches (Ec2) (0.1129) = Position in the Financial System (Ec3) (0.1129)*. Similarly, the ranking of the sub-criteria under the *Financial main criterion is: Cash Flow (F4) (0.3157) > Financial Growth (F2) (0.2014) = Risk (F5) (0.2014) > Capital Structure (F1) (0.1426) > Profitability (F3) (0.1388)*. Among all criteria, those with the least importance are Customer Satisfaction, Stakeholder Satisfaction, and Net Interest Margin. Criteria with high importance include Working Conditions, SDG Achievement Rate, Emission Policies, Waste Recycling Rate, Waste Reduction Initiatives, Loans, Support for Startups, Total Number of Branches, Fair Trade, Bank Income, Financial Growth, and Cash Flow. The most important criteria are Sustainable Products and Services, and R&D Employment. Notably, differences emerged between the two expert groups. While the A.E.G. emphasized environmental concerns, B.P.E.G. prioritized economic criteria. Both groups assigned similar weights to Innovation and Governance; however, Social and Financial dimensions were evaluated inversely. These distinctions are illustrated in Appendix 2 (Graphs 1–7), highlighting variations in expert perspectives on sustainability priorities within the banking sector.

As a result of the global weight calculations, several criteria were found to hold minimal importance, while others were identified as important or highly significant. Notably, differences emerged between the two expert groups. These are summarized in Table 2, which categorizes the

criteria according to their global weights. The observed divergence reflects a theoretical–practical distinction: academic experts tend to prioritize systemic, policy-oriented, and environmental dimensions of sustainability, whereas banking professionals emphasize operational, market-driven, and actionable factors. Recognizing and understanding these differing viewpoints is essential for aligning academic research with practical needs, ultimately contributing to more effective and balanced sustainable banking strategies.

Table 2. Least Important, Important and Most Important Criteria

	Academics	**Banking Professionals**
Least important criteria	Health and Safety Policies, Skill Development Policies, Disabled Employee Ratio, Average Training Duration, Anti-Corruption and Bribery Policies, Business Ethics, Employee Volunteering, External Audit Quality	Customer Satisfaction, Stakeholder Satisfaction, Net Interest Margin
High importance criteria	Non-Discrimination, Ease of Banking Transactions, Sustainable Products and Services., Resource Efficiency, Emission Policies, Total CO2 Emission, Total Recycled Waste Amount, Bank Income, Capital Structure, Financial Growth, Net Interest Margin	Working Conditions, SDG Achievement Rate, Emission Policies, Total Recycled Waste Amount, Waste Reduction Initiatives, Loans, Supports for Startups, Total Number of Branches, Fair Trade, Bank Income, Financial Growth, Cash Flow
The most important criteria	R&D, Total Waste Amount, Cash Flow	Sustainable Products and Services, R&D, Employment

4.2. Ranking the Banks: IF-WCC Approach with Non-Homogeneous Data Set

Measuring the sustainability performance of banks is a challenging process in many respects. In this complex decision-making problem, a dataset comprising *linguistic*, *interval-valued*, and *crisp* numbers data is encountered when attempting to rank alternatives using the BSSM. Banks were selected based on specific sustainability and scale-related criteria. These include being listed in ESG ratings, reporting 2021 data, inclusion in the GRI database and BIST Sustainability Index and a minimum of 500 branches (domestic and international). Additionally, all selected banks were among the largest in Türkiye, each with total assets exceeding 900 billion TL.

In the first phase, data collection was carried out for both crisp and interval-valued criteria. Sources included the Banks Association of Türkiye (primarily for financial and economic indicators), Refinitiv Eikon (for ESG data), and the banks' own sustainability, CSR, annual, or integrated reports, as well as Finbox and the banks' official websites. Following the data collection, expert assessments were conducted to gather linguistic evaluations. A new expert group was formed, consisting of five individuals (three men and two women), including customer relationship managers, headquarters professionals, and academics with 8 to 16 years of professional experience and diverse educational backgrounds (undergraduate to doctoral level). Using a brainstorming approach, the experts jointly provided evaluations of the banks based on linguistic terms defined in the scale presented in Table 3. This process yielded the complete raw dataset necessary for analysis.

To enable the transformation of heterogeneous data in the decision matrix into intuitionistic fuzzy numbers (IFNs), several transformation formulas were developed. These formulas allow for the uniform conversion of crisp, interval-valued, and linguistic data into IFNs, facilitating the consistent application of the proposed methodology. Let $A = \{A_1, A_2, \dots, A_m\}$ represent the set of alternatives, and $C = \{C_1, C_2, \dots, C_n\}$ represent the set of criteria. The decision matrix for each expert ${D_{(m\times n)}}^{(k)} = (a_{ij})^{(k)}_{(m\times n)}$ contains heterogeneous entries (a_{ij}), corresponding to different data types. The formulas used for these transformations based on the type of heterogeneous data are provided in Table 3 and Table 4. For criteria values that cannot be expressed using crisp number data, linguistic terms are often employed. Expressions such as *very high*, *high*, or *very low* allow decision-makers to evaluate alternatives according to the criteria without difficulty. Accordingly, data obtained in linguistic form can be easily converted into IFNs using the conversion scale provided in Table 3.

Table 3. Transformation of Linguistic Terms into Intuitionistic Fuzzy Numbers (IFNs)

Linguistic Term	IF Number Equivalent
Very High (VH)	(0.80, 0.10, 0.10)
High (H)	(0.70, 0.20, 0.10)
Slightly High (SH)	(0.60, 0.30, 0.10)
Medium (M)	(0.50, 0.40, 0.10)
Slightly Low (SL)	(0.40, 0.50, 0.10)
Low (L)	(0.25, 0.60, 0.15)
Very Low (VL)	(0.10, 0.75, 0.15)

Source: Cavallaro et al., 2018.

In some cases, criterion values for alternatives can be expressed as crisp numbers, such as costs or distances. However, in other situations, rather than a specific value, the criterion may be defined within a certain range. When such cases occur, the transformation formulas provided in Table 4 can be applied to easily convert all data into IFNs, thereby transforming the heterogeneous decision matrix into a homogeneous format suitable for further analysis.

To rank the banks based on their sustainability performance, a raw dataset table was constructed. Upon completing the raw dataset, the classification of the 60 criteria as either benefit criteria (to be maximized) or cost criteria (to be minimized) was determined through expert consultation and a detailed literature review. Following this, the second step involved transforming the raw data into a uniform format based on the type of data as follows: (1) Linguistic terms were converted into IFNs using the scale provided in Table 3; (2) Interval-valued criteria scores (e.g., A+, A, A−, ..., D, D−) were first transformed into interval values [L , U] using Table 5, and then into IFNs using Equations 8, 9, 10, and 11 in Table 4, depending on whether the criterion was a benefit or cost type; (3) Lastly, crisp numerical data (e.g., tons, Turkish Lira, ratios, quantities, hours, m³, tCO2e) were converted into IFNs using Equations 6 and 7 in Table 4, again based on whether each criterion was classified as a benefit or cost.

Table 4. Transformation of Crisp and Interval-Valued Numbers into Intuitionistic Fuzzy Numbers (IFNs)

Data Type	Criteria Type	Formulation	Eq. No.
Crisp → IFN	Benefit	$b_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{n}(a_{ij})^2}}$	(6)
	Cost	$b_{ij} = \frac{1/a_{ij}}{\sqrt{\sum_{i=1}^{n}(1/a_{ij})^2}}$	(7)
*Thus, crisp numbers are converted into IFNs as follows: $\boldsymbol{\mu_{ij} = b_{ij}}$, $\boldsymbol{v_{ij} = 1 - b_{ij}}$, $\boldsymbol{\pi_{ij} = 0}$			
Interval-valued → IFN	Benefit	$b_{ij}{}^{L} = \frac{a_{ij}^{L}}{\sqrt{\sum_{i=1}^{n}(a_{ij}^{U})^2}}$	(8)
		$b_{ij}{}^{U} = \frac{a_{ij}^{U}}{\sqrt{\sum_{i=1}^{n}(a_{ij}^{L})^2}}$	(9)
	Cost	$b_{ij}{}^{L} = \frac{1/a_{ij}^{L}}{\sqrt{\sum_{i=1}^{n}(1/a_{ij}^{U})^2}}$	(10)
		$b_{ij}{}^{U} = \frac{1/a_{ij}^{U}}{\sqrt{\sum_{i=1}^{n}(1/a_{ij}^{L})^2}}$	(11)
* Thus, IVNs are converted into IFNs as follows: $\boldsymbol{\mu_{ij} = b_{ij}^{L}}$, $\boldsymbol{v_{ij} = 1 - b_{ij}^{U}}$, $\boldsymbol{\pi_{ij} = b_{ij}^{U} - b_{ij}^{L}}$			

Source: Guo, 2013.

Through the transformation of all heterogeneous data into homogeneous data (i.e., IFNs), normalization was achieved, ensuring that all values fell within the [0,1] interval, and the subsequent steps of the analysis were carried out by constructing the intuitionistic fuzzy decision matrix.

Table 5. Transformation of Qualitative Scores into Numerical Interval Values [L , U]

Score	L	U
A+	0.9166	1
A	0.8333	0.9166
A-	0.75	0.8333
B+	0.6666	0.75
B	0.5833	0.6666
B-	0.5	0.5833
C+	0.4166	0.5
C	0.3333	0.4166
C-	0.25	0.3333
D+	0.1666	0.25
D	0.0833	0.1666
D-	0	0.0833

Source: Refinitv. 2022.

Additionally, IFSs and IFNs are designed to handle uncertainty. Even though some of the original data consisted of crisp numbers, it was observed that certain criterion values for the same bank were reported differently across various sources. To address this issue, converting such data

into IFNs ensured the accuracy of the analysis results and justified the necessity of IFN transformation. In the final step, WCC values were calculated to rank the banks based on their sustainability performance. These calculations were conducted using Equation 5. Furthermore, in the computations, the criterion weights obtained from the IVIF-BWM based on the assessments of banking professionals were employed. After performing all necessary calculations, the WCC values and the corresponding bank rankings in terms of sustainability performance were determined. These results are presented in Table 6. As shown in Table 6, Bank 1 ranks first with a WCC value of 0.799208, followed by Bank 4. Bank 3 and Bank 2. No significant differences were observed among the WCC values. This is primarily due to the fact that all four banks included in the analysis are among the leading institutions in Turkey in terms of their commitment to sustainability efforts.

Table 6. Ranking of Banks Based on Sustainability Performance

Alternatives	WCC Value	Rank
Bank 1	0.799208	1
Bank 2	0.632505	4
Bank 3	0.718258	3
Bank 4	0.758665	2

Source: Authors' own creation.

4.3. Sensitivity Analysis

Sensitivity analysis is a methodological tool used to examine how variations in input data affect the outcomes of a decision-making model. In the context of MCDM, sensitivity analysis typically involves assessing how changes in the weights assigned to criteria influence the ranking of alternatives. This step is crucial in validating the robustness and reliability of the results obtained from such models. Different approaches have been adopted in the literature for conducting sensitivity analyses. For instance, Çelik et al. (2022) employed a one-dimensional sensitivity analysis in their study. In this approach, the weight of the most important criterion is varied within a suitable range, while the remaining criteria weights are distributed equally. The formula used to determine the appropriate range for adjusting the most significant criterion's weight is derived from the work of Karande et al. (2016). Another approach is provided by Michailidou et al. (2016), who developed six distinct scenarios by increasing and decreasing the original criterion weights by 10%. 20%. and 30%. respectively. These variations were then compared with the baseline scenario to analyze the degree of fluctuation in the results. Similarly, Mishra et al. (2021) proposed a model involving nine criteria and performed a rotational sensitivity analysis across nine scenarios. In each scenario, a different criterion was assumed to be the most important by assigning it a higher weight. while the weights of other criteria were adjusted accordingly. This cyclic approach allowed them to observe changes in alternative rankings under all possible dominant-weight conditions and provided insights into the stability of rankings when each criterion's weight shifts from its minimum to maximum value. In another study, Şimşek Yağlı and Zengin Taşdemir (2023) used the weights obtained from the BWM as the baseline scenario. They then compared this with an equal-weight scenario and eight additional scenarios. In each of the eight, one criterion was given a dominant weight of 0.50, and the remaining five criteria were assigned equal shares of the residual weight. This approach enabled a comparative assessment of the model's sensitivity under highly skewed weight distributions.

Building upon these established methodologies, the current study developed ten distinct sensitivity scenarios to test the robustness of the results and to evaluate the potential impact of data uncertainty or inconsistencies in expert judgments. These scenarios include:

Scenario 1–2: Weight vectors obtained from the IVIF-BWM method based on two separate expert groups (professionals and academics);

Scenario 3: Weighting based on the Shannon Entropy method;

Scenario 4: Equal weighting of all main criteria;

Scenarios 5–10: Each of the six main criteria in the SIGEEF framework was individually assigned a dominant weight of 0.50, while the remaining five were each assigned weights of 0.10.

This comprehensive sensitivity analysis framework enhances the credibility of the model by revealing the stability or volatility of rankings across various weighting assumptions. It also demonstrates the model's capability to accommodate expert opinion variability and potential data imperfections. The results of the sensitivity analysis, illustrated in Figure 3 through a radar chart, indicate that the ranking of alternatives remained largely consistent across the ten evaluated scenarios. Minor deviations were observed in Scenario 3 and Scenario 8; however, in 80% of the scenarios, similar ranking patterns were maintained. Bank 1 predominantly ranked first, while Bank 2 consistently appeared in the last position. These findings confirm the reliability, robustness, and practical applicability of the proposed methodological framework, even under varying weighting schemes and potential uncertainty in expert judgments.

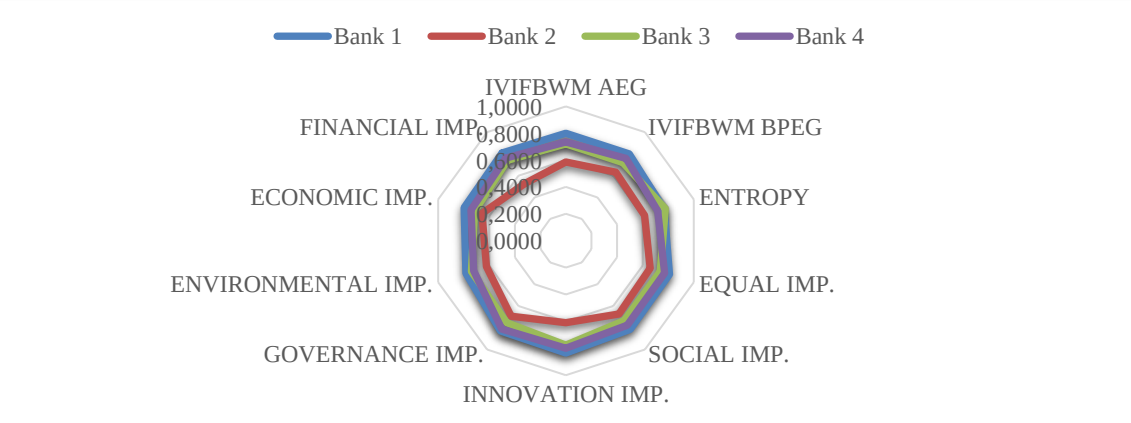


Figure 3. Radar Plot of Alternative Rankings Across Sensitivity Scenarios

5. Conclusions and Discussions

The banking sector, given its cross-sectoral influence, plays a pivotal role in shaping sustainable development. Therefore, there is a growing need for banks to assess their own sustainability performance and to benchmark themselves against industry peers. Such evaluations are critical for identifying areas of improvement, developing competitive strategies, and ensuring long-term success. However, sustainability performance evaluation in banking is inherently complex, involving diverse and sometimes conflicting economic, social, environmental, legal, ethical, and financial considerations (Stefanova. 2019). To address this complexity, this study introduces a novel methodological framework. The BSSM was established using major theories

(such as Stakeholder Theory, TBL, and Institutional Theory), significant literature study, and interaction with domain experts, and it provides a layered, multidimensional structure for assessing sustainability. The model comprises six main criteria; Social, Innovation, Governance, Environmental, Economic, and Financial (SIGEEF), supported by 23 second-level sub-criteria and 60 third-level indicators. This hierarchical structure facilitates clearer categorization and evaluation, enabling more effective decision-making.

Given the unequal importance of these criteria, the study utilizes a weighting process based on the BWM integrated with interval-valued intuitionistic fuzzy sets. This hybrid approach captures expert judgments under uncertainty and imprecision. The evaluation was conducted with input from two expert perspectives: the academics and the banking professionals expert groups, respectively. The results indicate variying perspectives: A.E.G. prioritized the environmental dimension (weight: 0.2576), followed by financial and social aspects, whereas B.P.E.G. considered the economic dimension most important (weight: 0.2449), with environmental and social factors ranked equally. Governance and financial criteria were deemed least important by each group, respectively. Here, Institutional and Stakeholder Theory can be used to analyze the differences between professional and academic experts. Operating within a normative framework, academic experts typically prioritize governance and environmental issues, reflecting long-term social expectations. On the other hand, banking professionals are more impacted by market and coercive forces, focusing on financial and economic aspects to maintain operational stability and competitiveness. This implies that, to reconcile theoretical aspirations with real-world realities, there needs to be greater alignment between sustainability concepts and banking practice. Moreover, these differences underscore the necessity for enhanced collaboration among stakeholders to align priorities and optimize resource allocation. Effective banking efforts to promote sustainability must therefore close this gap by utilizing incentive programs, integrated policy frameworks, and ESG-linked financial products that match theoretical goals with real-world application.

This study provides several valuable theoretical and practical contributions to the field of sustainability performance evaluation, particularly within the context of the banking sector. First, the model developed, namely, the BSSM, represents a novel approach that addresses the lack of a comprehensive, sector-specific model tailored to the unique dynamics of the banking industry. By incorporating a multi-dimensional and hierarchical structure, the BSSM enables nuanced assessments across various sustainability dimensions and supports both academic research and managerial decision-making. From a theoretical standpoint, the study expands on the traditional TBL framework and Stakeholder theory by incorporating ideas from institutional and dynamic capability into a multifaceted framework designed especially for banking. Furthermore, the findings imply that the observed discrepancies have important ramifications for sustainable finance governance. Banks that prioritize economic and financial aspects, for instance, run the danger of underfunding long-term social or environmental projects. On the other hand, stability may be jeopardized if environmental concerns are overemphasized without being financially feasible. Thus, a well-rounded strategy based on the multifaceted SIGEEF framework can aid in resolving these conflicting priorities and promoting stakeholder alignment. Second, the application of the BSSM using real-world data demonstrates the model's practical relevance and usability. It shows that banks can utilize the framework to benchmark their performance, identify areas of strength and weakness, and develop actionable strategies for improvement. The model's structure also allows for the disaggregation of sustainability into distinct dimensions, SIGEEF,

thereby enabling focused evaluations and the development of sub-models tailored to each dimension. Moreover, the framework is designed to be compatible with various MCDM techniques, facilitating methodological flexibility and comparability across studies. Third, the integration of expert opinions from both academic and professional domains enhances the validity of the model. Considering different stakeholder perspectives helps to fill potential information gaps and ensures that the model reflects diverse expectations and realities. This multi-stakeholder approach not only strengthens the robustness of the evaluation process but also fosters collaboration in sustainability planning. From a practical perspective, the use of multiple quantitative methods. including the IVIF-BWM and IF-WCC, enhances the credibility and objectivity of the evaluation results. These methods support the derivation of measurable, transparent, and reproducible outcomes, which are critical for building trust and comparability in sustainability assessments. Importantly, the identification of the relative importance of evaluation criteria provides decision-makers with critical insights into how to prioritize initiatives and allocate scarce resources effectively. At the same time, the observed differences in criteria importance between academic and industry experts highlight the need for continuous dialogue to reconcile divergent views and develop shared priorities. Furthermore, the BSSM enables banks to position themselves competitively within the sector by identifying their relative performance rankings and taking necessary actions to enhance their sustainability standing. This capability supports long-term strategic planning and may contribute to the development of competitive advantages (Nizam et al., 2019). Based on the evaluation outcomes, banks can also implement tailored training programs, develop internal policies, and revise operational procedures to address specific performance gaps. Moreover, the structured definition of criteria using different data types, crisp, linguistic, and interval-valued, also provides guidance for future data collection and helps standardize sustainability reporting. The adoption of quantitative. fuzzy-based approaches further enhances the reliability of evaluations. enabling robust benchmarking and facilitating informed decision-making. Although the BSSM was specifically designed for the banking sector, its adaptable structure allows for modification of criteria, making it a flexible and scalable tool applicable for sustainability assessment in other sectors as well. The BSSM-based rankings allow banks to pinpoint areas that need improvement in terms of policy and strategic implications. By increasing stakeholder involvement, investing in the community, or implementing green financing programs, banks with poor social or environmental scores can improve their sustainability profiles. In a similar vein, regulatory bodies can use these rankings to create focused sustainability disclosure guidelines, which will increase responsibility and openness in the industry. Overall, the findings highlight how crucial multi-stakeholder cooperation and context-sensitive assessment methods are to creating a robust and sustainable banking environment. In summary, the BSSM advances the discourse on sustainable banking by providing a theoretically grounded. empirically validated, and practically applicable model that supports informed decision-making, accountability, and strategic sustainability transformation within the financial sector. In this way, it can be stated that all research objectives have been achieved.

As with any empirical research, this study is subject to several limitations. The first limitation lies in the sector-specific nature of the proposed methodological framework. Although it is theoretically adaptable to other sectors through appropriate updates and modifications, the current implementation is limited to the banking industry. Therefore, the generalizability of the findings should be interpreted within this context. The second limitation concerns the challenges encountered in gathering expert opinions. Limited availability of experts and time constraints

made data collection particularly demanding. Another significant limitation involves access to data. While financial information from banks is generally accessible, sustainability-related data, especially in the areas of social, governance, and environmental performance, are often either not reported or remain incomplete. Consequently, the application phase of the model was restricted to only four banks due to these data limitations. A further limitation concerns the subjective nature of some data inputs within the framework. particularly those used in weighting and ranking processes. As such, the results may vary depending on temporal, geographical, sectoral, or individual differences in expert judgment.

Based on these limitations, several suggestions are offered for future research. First, once data accessibility challenges are mitigated, the model should be applied across a broader sample encompassing the entire banking sector. Second, the robustness and validity of the proposed framework can be further tested by employing alternative MCDM techniques. Third, the framework could be revised and applied to other sectors by adapting the criteria to suit sector-specific sustainability dynamics. Future research may empirically test the theoretical linkages between the SIGEEF dimensions and firm performance. Finally, future studies may consider integrating alternative fuzzy set extensions into the methodology to enrich the analytical depth and interpretability of results.

Declaration of Research and Publication Ethics
Ethical approval for the study were obtained from Nevşehir Hacı Bektaş Veli University Ethics Committee (Date: 09/08/2022, No: 08, Decision No: 261). This study complies with research and publication ethics.

Researcher's Contribution Rate Statement
The authors declare that they have contributed equally to the article.

Declaration of Researcher's Conflict of Interest
There are no potential conflicts of interest in this study.

References

Abdel-Basset, M., Ding, W., Mohamed, R. and Metawa, N. (2020). An integrated plithogenic MCDM approach for financial performance evaluation of manufacturing industries. *Risk Management*, 22(3), 192–218. https://doi.org/10.1057/s41283-020-00061-4

Ahmed, S.U., Islam, Z.M. and Hasan, I. (2012). Corporate social responsibility and financial performance linkage: Evidence from the banking sector of Bangladesh. *Journal of Organizational Management*, 1(1), 14–21. Retrieved from http://www.hgpub.com/jorm.html

Amor, S.B., de Almeida, A.T., de Miranda, J.L. and Aktas, E. (Eds.). (2020). *Advanced studies in multi-criteria decision making*. USA: CRC Press.

Aracil, E., Nájera-Sánchez, J.J. and Forcadell, F.J. (2021). Sustainable banking: A literature review and integrative framework. *Finance Research Letters*, 42, 101932. https://doi.org/10.1016/j.frl.2021.101932

Aras, G., Tezcan, N. and Furtuna, O.K. (2018). Multidimensional comprehensive corporate sustainability performance evaluation model: Evidence from an emerging market banking sector. *Journal of Cleaner Production*, 185, 600–609. https://doi.org/10.1016/j.jclepro.2018.01.175

Aras, G., Tezcan, N., Furtuna, O.K. and Kazak, E.H. (2017). Corporate sustainability measurement based on entropy weight and TOPSIS: A Turkish banking case study. *Meditari Accountancy Research*, 25(3), 391–413. https://doi.org/10.1108/MEDAR-11-2016-0100

Ashraf, M., Khan, B. and Tariq, R. (2017). Corporate social responsibility impact on financial performance of banks: Evidence from Asian countries. *International Journal of Academic Research in Business and Social Sciences*, 7(4), 618–632. Retrieved from http://hrmars.com/hrmars_papers/

Barbosa, M.W. and de Oliveira, V.M. (2021). The corporate social responsibility professional: A content analysis of job advertisements. *Journal of Cleaner Production*, 279, 123665. https://doi.org/10.1016/j.jclepro.2020.123665

Belton, V. and Stewart, T. (2002). *Multiple criteria decision analysis: An integrated approach*. Berlin: Springer Science and Business Media.

Bouma, J.J., Jeucken, M. and Klinkers, L. (2017). *Sustainable banking: The greening of finance*. London: Routledge.

Büyüközkan, G., Havle, C.A. and Feyzioğlu, O. (2020). A new digital service quality model and its strategic analysis in aviation industry using interval-valued intuitionistic fuzzy AHP. *Journal of Air Transport Management*, 86, 101817. https://doi.org/10.1016/j.jairtraman.2020.101817

Carayannis, E.G., Ferreira, J.J., Jalali, S. and Ferreira, F.A. (2018). MCDA in knowledge-based economies: Methodological developments and real-world applications. *Technological Forecasting and Social Change*, 131, 1–3. https://doi.org/10.1016/j.techfore.2018.01.028

Cavallaro, F., Zavadskas, E.K. and Streimikiene, D. (2018). Concentrated solar power (CSP) hybridized systems: Ranking based on an intuitionistic fuzzy multi-criteria algorithm. *Journal of Cleaner Production*, 179, 407–416. https://doi.org/10.1016/j.jclepro.2017.12.269

Chejarla, K.C., Vaidya, O.S. and Kumar, S. (2022). MCDM applications in logistics performance evaluation: A literature review. *Journal of Multi-Criteria Decision Analysis*, 29(3–4), 274–297. https://doi.org/10.1002/mcda.1774

Chowdhury, M.M.H. and Paul, S.K. (2020). Applications of MCDM methods in sustainable supply chain management: A systematic review. *Sustainable Production and Consumption*, 23, 122–144. https://doi.org/10.1108/MEQ-12-2019-0284

Çelik, S., Peker, İ., Gök-Kısa, A.C. and Büyüközkan, G. (2022). Multi-criteria evaluation of medical waste management process under intuitionistic fuzzy environment: A case study on hospitals in Turkey. *Socio-Economic Planning Sciences*, 101499. https://doi.org/10.1016/j.seps.2022.101499

Çelikbilek, Y. and Tüysüz, F. (2020). An in-depth review of the theory of the TOPSIS method: An experimental analysis. *Journal of Management Analytics*, 7(2), 281–300. https://doi.org/10.1080/23270012.2020.1748528

DiMaggio, P.J. and Powell, W.W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2), 147-160. Retrieved from https://www.jstor.org/

Ecer, F. and Pamucar, D. (2022). A novel LOPCOW-DOBI multi-criteria sustainability performance assessment methodology: An application in developing country banking sector. *Omega*, 112, 102690. https://doi.org/10.1016/j.omega.2022.102690

El Amine, M., Pailhes, J. and Perry, N. (2014). Critical review of multi-criteria decision aid methods in conceptual design phases: Application to the development of a solar collector structure. *Procedia CIRP*, 21, 497–502. https://doi.org/10.1016/j.procir.2014.03.134

Elkington, J. (1997). The triple bottom line. In M. V. Russo (Eds.), *Environmental management: Readings and cases* (pp. 49-66). USA: SAGE Publications.

Esangbedo, M.O., Bai, S., Mirjalili, S. and Wang, Z. (2021). Evaluation of human resource information systems using grey ordinal pairwise comparison MCDM methods. *Expert Systems with Applications*, 182, 115151. https://doi.org/10.1016/j.eswa.2021.115151

Freeman, R.E. and McVea, J. (2005) A stakeholder approach to strategic management. In M.A. Hitt, R. E. Freeman and J.S. Harrison (Eds.), *The Blackwell handbook of strategic management* (pp. 183-201). Oxford: Blackwell Publishers.

Gangi, F., Mustilli, M. and Varrone, N. (2018). The impact of corporate social responsibility (CSR) knowledge on corporate financial performance: Evidence from the European banking industry. *Journal of Knowledge Management*, 23(1), 110–134. https://doi.org/10.1108/JKM-04-2018-0267

Gerstenkorn, T. and Mańko, J. (1991). Correlation of intuitionistic fuzzy sets. *Fuzzy Sets and Systems*, 44(1), 39–43. https://doi.org/10.1016/0165-0114(91)90031-K

Hassan, A. and Harahap, S.S. (2010). Exploring corporate social responsibility disclosure: The case of Islamic banks. *International Journal of Islamic and Middle Eastern Finance and Management*, 3(3), 203–227. https://doi.org/10.1108/17538391011072417

Islam, M.A., Makripoulias, K. and Tedford, D. (2012). The relationship between corporate social responsibility and financial performance: Evidence from the banking industry. *International Journal of Business and Management Tomorrow*, 2(5), 1–8. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract

Karagiorgos, T. (2010). Corporate social responsibility and financial performance: An empirical analysis on Greek companies. *European Research Studies*, 13(4), 85–106. Retrieved from https://www.um.edu.mt/

Karande, P., Zavadskas, E. and Chakraborty, S. (2016). A study on the ranking performance of some MCDM methods for industrial robot selection problems. *International Journal of Industrial Engineering Computations*, 7(3), 399–422. https://doi.org/10.5267/j.ijiec.2016.1.001

Karaşan, A., Kaya, İ. and Erdoğan, M. (2020). Location selection of electric vehicle charging stations by using a fuzzy MCDM method: A case study in Turkey. *Neural Computing and Applications*, 32(9), 4553–4574. https://doi.org/10.1007/s00521-018-3752-2

Kaya, İ., Çolak, M. and Terzi, F. (2018). Use of MCDM techniques for energy policy and decision-making problems: A review. *International Journal of Energy Research*, 42(7), 2344–2372. https://doi.org/10.1002/er.4016

Khattak, M.A. (2021). Corporate sustainability and financial performance of banks in Muslim economies: The role of institutions. *Journal of Public Affairs*, 21(1), e2156. https://doi.org/10.1002/pa.2156

Kiliç, M., Kuzey, C. and Uyar, A. (2015). The impact of ownership and board structure on corporate social responsibility (CSR) reporting in the Turkish banking industry. *Corporate Governance*, 15(3), 357–374. https://doi.org/10.1108/CG-02-2014-0022

Korzeb, Z. and Samaniego-Medina, R. (2019). Sustainability performance: A comparative analysis in the Polish banking sector. *Sustainability*, 11(3), 653. https://doi.org/10.3390/su11030653

Kumar, G., Subramanian, N. and Arputham, R.M. (2018). Missing link between sustainability collaborative strategy and supply chain performance: Role of dynamic capability. *International Journal of Production Economics*, 203, 96–109. https://doi.org/10.1016/j.ijpe.2018.05.031

Mi, X., Tang, M., Liao, H., Shen, W. and Lev, B. (2019). The state-of-the-art survey on integrations and applications of the best worst method in decision making: Why. what. what for and what's next? *Omega*, 87, 205–225. https://doi.org/10.1016/j.omega.2019.01.009

Michailidou, A.V., Vlachokostas, C. and Moussiopoulos, N. (2016). Interactions between climate change and the tourism sector: Multiple-criteria decision analysis to assess mitigation and adaptation options in tourism areas. *Tourism Management*, 55, 1–12. https://doi.org/10.1016/j.tourman.2016.01.010

Mishra, A.R., Mardani, A., Rani, P., Kamyab, H. and Alrasheedi, M. (2021). A new intuitionistic fuzzy combinative distance-based assessment framework to assess low-carbon sustainable suppliers in the maritime sector. *Energy*, 237, 121500. https://doi.org/10.1016/j.energy.2021.121500

Mohammadi, S.S., Azar, A., Ghatari, A.R. and Alimohammadlou, M. (2022). A model for selecting green suppliers through interval-valued intuitionistic fuzzy multi-criteria decision making models. *Journal of Management Analytics*, 9(1), 60–85. https://doi.org/10.1080/23270012.2021.1881926

Morioka, S.N. and de Carvalho, M.M. (2016). A systematic literature review towards a conceptual framework for integrating sustainability performance into business. *Journal of Cleaner Production*, 136, 134–146. https://doi.org/10.1016/j.jclepro.2016.01.104

Nájera-Sánchez, J.J. (2019). A systematic review of sustainable banking through a co-word analysis. *Sustainability*, 12(1), 278. https://doi.org/10.3390/su12010278

Nepomuceno, T.C.C., de Carvalho, V.D.H., Poleto, T. and Figueiredo, C.J.J. (2024). A knowledge-based directional multicriteria framework with defuzzified subset of preferences for sustainable banking strategy analysis. *International Journal of Bank Marketing*, 42(7), 1888–1919. https://doi.org/10.1108/IJBM-12-2023-0653

Nizam, E., Ng, A., Dewandaru, G., Nagayev, R. and Nkoba, M.A. (2019). The impact of social and environmental sustainability on financial performance: A global analysis of the banking sector. *Journal of Multinational Financial Management*, 49, 35–53. https://doi.org/10.1016/j.mulfin.2019.01.002

Ohene-Asare, K. and Asmild, M. (2012). Banking efficiency analysis under corporate social responsibilities. *International Journal of Banking. Accounting and Finance*, 4(2), 146–171. https://doi.org/10.1504/IJBAAF.2012.048331

Onar, S.C., Oztaysi, B., Otay, İ. and Kahraman, C. (2015). Multi-expert wind energy technology selection using interval-valued intuitionistic fuzzy sets. *Energy*, 90, 274–285. https://doi.org/10.1016/j.energy.2015.06.086

Özçelik, F. and Avcı Öztürk, B. (2014). Evaluation of banks' sustainability performance in Turkey with grey relational analysis. *Journal of Accounting and Finance*, 63, 189–210. Retrieved from https://dergipark.org.tr/tr/pub/mufad

Pala, F. (2022). Bankacılık sektöründe kurumsal sosyal sorumluluk ile finansal performans arasındaki ilişki: Türkiye örneği. *Cumhuriyet Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 23(1), 49–78. https://doi.org/10.37880/cumuiibf.989475

Pamuçar, D., Ecer, F., Cirovic, G. and Arlasheedi, M.A. (2020). Application of improved best worst method (BWM) in real-world problems. *Mathematics*, 8(8), 1342. https://doi.org/10.3390/math8081342

Pour, B.S., Nazari, K. and Emami, M. (2014). Corporate social responsibility: A literature review. *African Journal of Business Management*, 8(7), 228–234. Retrieved from http://www.academicjournals.org/AJBM

Rabea'Hadi, M. Hasan, M.F., Flayyih, H.H. and Hussein, M.K. (2023). Green banking: A literature review on profitability and sustainability implications. *Ishtar Journal of Economics and Business Studies*, 4(2), 1–6. https://doi.org/10.55270/ijebs.v4i2.27

Raut, R., Cheikhrouhou, N. and Kharat, M. (2017). Sustainability in the banking industry: A strategic multi-criterion analysis. *Business Strategy and the Environment*, 26(4), 550–568. https://doi.org/10.1002/bse.1946

Refinitiv. (2022). *Environmental. social and governance scores from Refinitiv*. Retrieved from https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf

Rezaei, J. (2015). Best-worst multi-criteria decision-making method. *Omega*, 53, 49–57. https://doi.org/10.1016/j.omega.2014.11.009

Rezaei, J., Nispeling, T., Sarkis, J. and Tavasszy, L. (2016). A supplier selection life cycle approach integrating traditional and environmental criteria using the best worst method. *Journal of Cleaner Production*, 135, 577–588. https://doi.org/10.1016/j.jclepro.2016.06.125

Shao, M., Han, Z., Sun, J., Xiao, C., Zhang, S. and Zhao, Y. (2020). A review of multi-criteria decision making applications for renewable energy site selection. *Renewable Energy*, 157, 377–403. https://doi.org/10.1016/j.renene.2020.04.137

Sharma, D. and Kumar, P. (2024). Prioritizing the attributes of sustainable banking performance. *International Journal of Productivity and Performance Management*, 73(6), 1797–1825. https://doi.org/10.1108/IJPPM-11-2022-0600

Stauropoulou, A. and Sardianou, E. (2019). Understanding and measuring sustainability performance in the banking sector. *IOP Conference Series: Earth and Environmental Science*, 362(1), 012128. doi:10.1088/1755-1315/362/1/012128

Stefanova, M. (2019). The CSR professional – Undiscovered agent of change. *Economic Alternatives*, 2, 313–323. Retrieved from https://www.unwe.bg/

Şimşek Yağlı, B. and Zengin Taşdemir, S. (2023). Bütünleşik BWM ve TOPSIS yöntemleri kullanılarak OPEC üyesi ülkeler için kurumsal gelişmişlik analizi. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* 16(1), 119–135. https://doi.org/10.25287/ohuiibf.1103498

Simsek Yagli, B., Dogan, N.O. and Yagli, I. (2022). Weighting ESG criteria of banks by using interval valued intuitionistic fuzzy best worst method. In C. Kahraman, A.C. Tolga, S. Cevik Onar, S. Cebi, B. Oztaysi and U. Ucar Sari (Eds.), *International conference on intelligent and fuzzy systems* (pp. 598–605). Berlin: Springer.

Teece, D.J. (2018). Business models and dynamic capabilities. *Long Range Planning*, 51(1), 40-49. https://doi.org/10.1016/j.lrp.2017.06.007

TBB. (2023). *Sustainability in banking: Sectoral outlook report*. Retrieved from https://www.tbb.org.tr/en/pdf/faaliyetler/116/5314

UNEP FI. (2024). *Principles for responsible banking: Annual report 2023*. Retrieved from https://www.unepfi.org/industries/banking/prb-2nd-progress-report/

Vatankhah, S., Darvishmotevali, M., Rahimi, R., Jamali, S.M. and Ale Ebrahim, N. (2023). Assessing the application of multi-criteria decision making techniques in hospitality and tourism research: A bibliometric study. *International Journal of Contemporary Hospitality Management*, 35(7), 2590–2623. https://doi.org/10.1108/IJCHM-05-2022-0643

Wang, J., Ma, Q. and Liu, H.C. (2021). A meta-evaluation model on science and technology project review experts using IVIF-BWM and MULTIMOORA. *Expert Systems with Applications*, 168, 114236. https://doi.org/10.1016/j.eswa.2020.114236

Wang, P., Zhu, Z., and Huang, S. (2017). The use of improved TOPSIS method based on experimental design and Chebyshev regression in solving MCDM problems. *Journal of Intelligent Manufacturing*, 28(1), 229–243. https://doi.org/10.1007/s10845-014-0973-9

Wang, Z., Reimsbach, D. and Braam, G. (2018). Political embeddedness and the diffusion of corporate social responsibility practices in China: A trade-off between financial and CSR performance? *Journal of Cleaner Production*, 198, 1185–1197. https://doi.org/10.1016/j.jclepro.2018.07.116

Weber, O. (2017). Corporate sustainability and financial performance of Chinese banks. *Sustainability Accounting. Management and Policy Journal*, 8(3), 358–385. https://doi.org/10.1108/SAMPJ-09-2016-0066

World Economic Forum. (2024). *Global risks report 2024*. Retrieved from https://www.weforum.org/reports/global-risks-report-2024

Ye, J. (2010). Fuzzy decision-making method based on the weighted correlation coefficient under intuitionistic fuzzy environment. *European Journal of Operational Research*, 205(1), 202–204. https://doi.org/10.1016/j.ejor.2010.01.019

Zhou, H., Yang, Y., Chen, Y., and Zhu, J. (2018). Data envelopment analysis application in sustainability: The origins. development and future directions. *European Journal of Operational Research*, 264(1), 1–16. https://doi.org/10.1016/j.ejor.2017.06.023

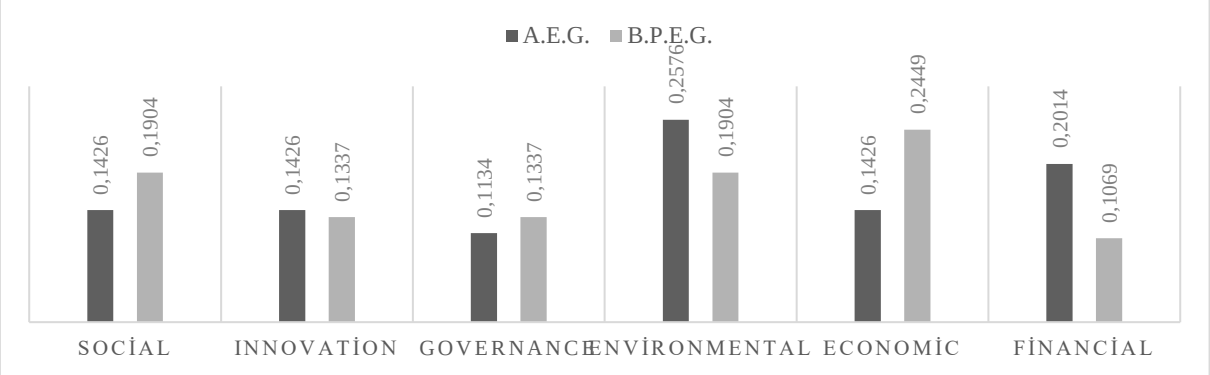
APPENDIX

Table A1. BSSM criteria and its references

1 Main Criteria		2. Sub- Criteria		References
1. Sub- Criteria				
1- SOCIAL (S)				
(S1)	Human Resources	(S1-1)	Health and Safety Policies	(ESG – GRI – TBL – Aras et al., 2018 – Kilic et al., 2015 – Taşkın, 2015 – Ecer, 2019 – Karagiorgos, 2010 – Oliveira et al., 2019 – Govindan et al., 2014 – Rebai et al., 2016 – Ömürbek et al., 2017 – Sobhani et al., 2012 – Ahmadi et al., 2017)
		(S1-2)	Education and Development Policies	
		(S1-3)	Skill Development Policies	
		(S1-4)	Average Employee Income *	
		(S1-5)	Female Employee Ratio *	
		(S1-6)	Female Executive Ratio *	
		(S1-7)	Disabled Employee Ratio *	
		(S1-8)	Employee Turnover Rate *	
		(S1-9)	Average Training Duration *	
		(S1-10)	Promotions	
		(S1-11)	Employee Satisfaction	
(S2)	Social Relationships	(S2-1)	Anti-Corruption and Bribery Policy	
		(S2-2)	Business Ethics	
		(S2-3)	Community Engagement	
		(S2-4)	Donations *	
		(S2-5)	Employee Volunteering	
		(S2-6)	Customer Satisfaction	
(S3)	Human Rights	(S3-1)	Working Conditions	
		(S3-2)	Non-Discrimination	
		(S3-3)	Work-Life Balance	
		(S3-4)	Equal Opportunity	
2- INNOVATION (I)				
(I1)	Digitalization	(I1-1)	Internet Banking Quality	(ESG – Goyal et al., 2015 – Kilic et al., 2015 – Karaman and Akman, 2018 – Ahmed et al., 2012 – Korzeb et al., 2019 – Govindan, 2022)
		(I1-2)	Mobile Banking Quality	
		(I1-3)	Ease of Banking Transactions	
		(I1-4)	Total Number of ATMs *	
(I2)	Sustainable Products And Services			
(I3)	R &D *			
3- GOVERNANCE (G)				
(G1)	Management	(G1-1)	Corporate Governance Structure	(ESG – Govindan et al., 2014 – Rafinda et al., 2018 – Szegedi et al., 2020 – Ahmed et al., 2012 – Aras et al., 2018)
		(G1-2)	Independent Board Member Rate *	
		(G1-3)	Female Board Member Rate *	
		(G1-4)	Internal Audit Quality	
		(G1-5)	Crisis Management System	
(G2)	Stakeholders	(G2-1)	Responsible Marketing Policies	
		(G2-2)	Customer Privacy	
		(G2-3)	Data Security	
		(G2-4)	Stakeholder Satisfaction	
(G3)	CSR Strategy	(G3-1)	CSR Management	
		(G3-2)	External Audit Qualiy	
		(G3-3)	SDG Achievement Rate *	
		(G3-4)	Effective Sustainability Communication	

Table A1. Continued

4- ENVIRONMENTAL (E)				
(E1)	Resource Usage	(E1-1)	Resource Efficiency	(ESG – TBL – GRI – Aras et al., 2018 – Ecer, 2019 – Govindan et al., 2014 – Sobhani et al., 2012)
		(E1-2)	Environment Management Team	
		(E1-3)	Environment Management Training	
		(E1-4)	Total Energy Consumption *	
		(E1-5)	Total Water Consumption *	
		(E1-6)	Total Paper Consumption *	
(E2)	Emissions	(E2-1)	Emission Policies	
		(E2-2)	Total CO_2 Emission *	
(E3)	Waste Management	(E3-1)	Total Waste Amount *	
		(E3-2)	Total Recycled Waste Amount *	
		(E3-3)	Waste Reduction Initiatives	
5- ECONOMIC (E)				
(Ec1)	Contribution to the Economy	(Ec1-1)	Loans *	(TBL – GRI – Aras et al., 2018 – Ecer, 2019 – Rebai et al., 2016 – Goyal et al., 2015 – Taskin, 2015 – Sustainable Work Awards – Ömürbek et al., 2017 – Mallin et al., 2014)
		(Ec1-2)	Supports for StartUps	
(Ec2)	Total Number of Branches *			
(Ec3)	Position in the Financial System	(Ec3-1)	Total Assets *	
		(Ec3-2)	Total Loans *	
		(Ec3-3)	Total Deposits*	
(Ec4)	Fair Trade			
(Ec5)	Bank Income *			
(Ec6)	Employment *			
6- FINANCIAL (F)				
(F1)	Capital Structure *			(TBL – Aras et al., 2018 – Omurbek et al., 2017 – Ecer, 2019 – Ozcelik et al., 2014 – Govindan et al., 2014 – Taskin, 2015 – Karagiorgos, 2010 – Rafinda et al., 2018)
(F2)	Financial Growth *			
(F3)	Profitability *	(F3-1)	Return on Equity (ROE) *	
		(F3-2)	Return on Assets (ROA) *	
		(F3-3)	Net Interest Margin *	
(F4)	Cash Flow *			
(F5)	Risk	(F5-1)	Financial Risk Management	
		(F5-2)	CAPM Beta *	
		(F5-3)	Altman Z Score *	

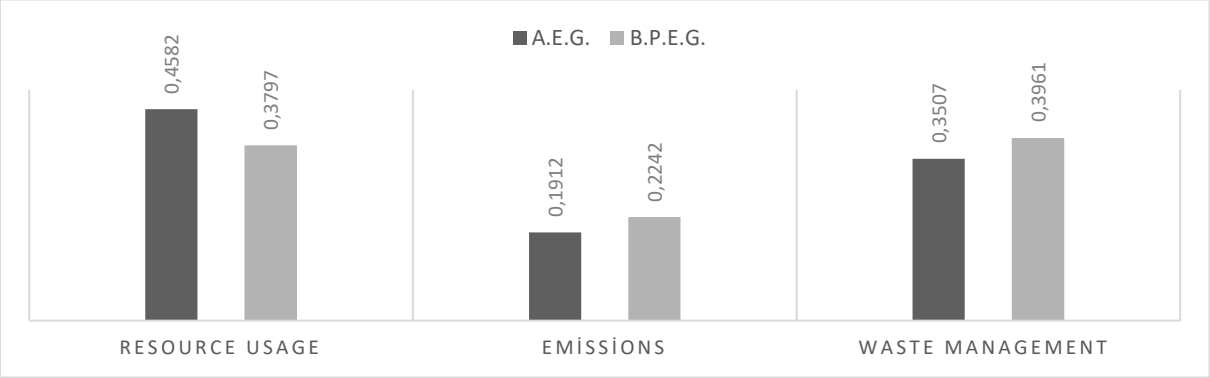


Graph A1. Comparison of Main Criteria Weights

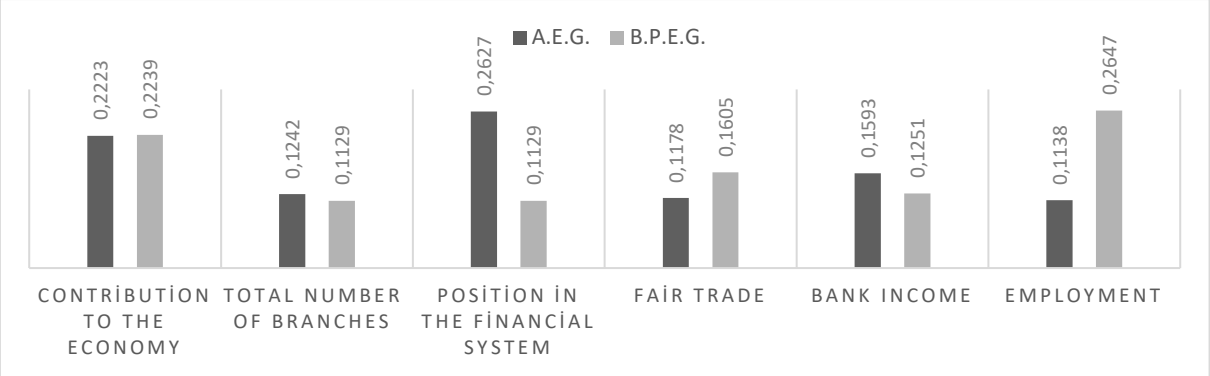
Graph A2. Comparison of Sub-Criterion Weights for the Social Criterion

Graph A3. Comparison of Sub-Criteria Weights for the Innovation Criterion

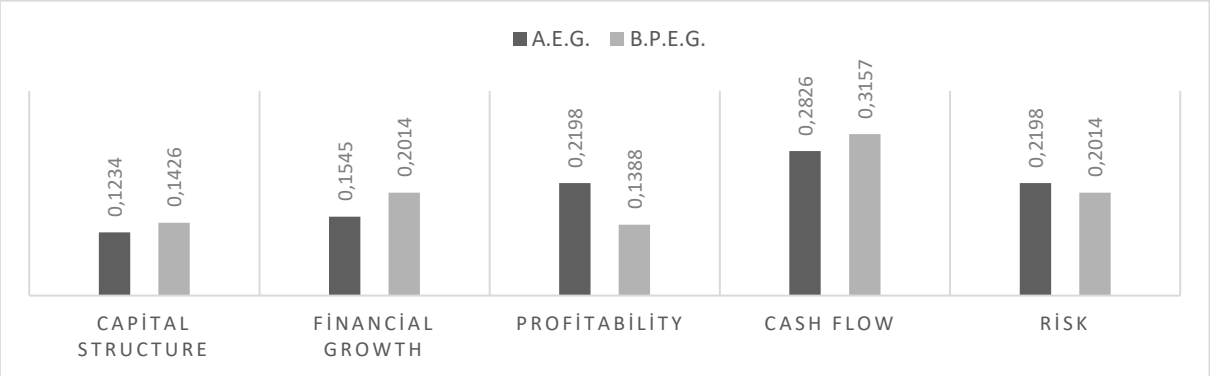
Graph A4. Comparison of Sub-Criteria Weights under the Governance Criterion



Graph A5. Comparison of the Weights of Sub-Criteria under the Environmental Criterion



Graph A6. Comparison of Sub-Criteria Weights for the Economic Criterion



Graph A7. Comparison of Sub-Criteria Weights for the Financial Criterion