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## MEASURING ENVIRONMENTAL SUSTAINABILITY IN THE TURKISH BANKING SECTOR: COMPOSITE SCORING OF ESG-E PERFORMANCE (2022–2024)

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### ABSTRACT

This study conducts a structured assessment of the environmental sustainability performance of six leading Turkish banks between 2022 and 2024. Using ten ESG (Environmental, Social, and Governance) indicators, including CDP climate and water scores, emissions data, resource usage metrics, and environmental efficiency ratios, the analysis converts diverse inputs into comparable results through a standardized normalization process. Both direct and inverse normalization techniques are applied to construct a single composite ESG score for each institution. The results reveal notable disparities in sustainability performance: GARAN outperforms its peers, demonstrating robust integration of environmental practices, while ALBRK lags due to high resource consumption and poor emissions efficiency. YKBNK and HALKB show strong environmental disclosures but weaker operational execution, indicating a disconnect between policy statements and tangible outcomes. This research contributes to the literature by offering a replicable ESG scoring model tailored to the Turkish banking sector, providing empirical benchmarks for sustainability performance. The model enhances transparency, supports stakeholder evaluations, and informs sustainable finance strategies.

**Keywords:** ESG performance, sustainability scoring, composite environmental index, Turkish banking sector.

## TÜRK BANKACILIK SEKTÖRÜNDE ÇEVRESEL SÜRDÜRÜLEBİLİRLİĞİN ÖLÇÜLMESİ: ESG-E PERFORMANSININ BİLEŞİK SKORLA DEĞERLENDİRİLMESİ (2022–2024)

### ÖZ

Bu çalışma, 2022–2024 yılları arasında altı önde gelen Türk bankasının çevresel sürdürülebilirlik performansını yapılandırılmış bir biçimde değerlendirmektedir. CDP iklim ve su skorları, emisyon verileri, kaynak kullanımı göstergeleri ve çevresel verimlilik oranları dahil olmak üzere on adet ÇSY (Çevresel, Sosyal ve Yönetişim) göstergesinden yararlanılarak yürütülen analiz, farklı türdeki verileri standartlaştırılmış bir normalizasyon süreci aracılığıyla karşılaştırılabilir sonuçlara dönüştürmektedir. Her banka için tekil bir bileşik ESG skoru oluşturmak amacıyla hem doğrudan hem de ters normalizasyon teknikleri uygulanmaktadır. Elde edilen bulgular, sürdürülebilirlik performansı açısından anlamlı farklılıkları ortaya koymaktadır: GARAN, çevresel uygulamaların güçlü entegrasyonunu sergileyerek diğer bankaların önüne geçerken; ALBRK, yüksek kaynak tüketimi ve düşük emisyon verimliliği nedeniyle geride kalmaktadır. YKBNK ve HALKB çevresel açıklama konusunda güçlü bir performans sergilemekle birlikte, operasyonel uygulamada geri planda kalmakta; bu durum politika söylemleri ile somut sonuçlar arasındaki uyumsuzluğa işaret etmektedir. Bu araştırma, Türk bankacılık sektörüne özgü tekrarlanabilir bir ESG skorlama modeli sunarak literatüre yöntemsel katkı sağlamakta; sürdürülebilirlik performansına ilişkin ampirik kıyaslamalar aracılığıyla şeffaflığı artırmakta, paydaş değerlendirmelerini desteklemekte ve sürdürülebilir finans stratejileri için yol göstermektedir.

**Anahtar Kelimeler:** ESG performansı, sürdürülebilirlik puanlaması, bileşik çevresel endeks, Türk bankacılık sektörü.

## 1. Introduction

Environmental, social, and governance (ESG) factors have been at the heart of measuring corporate sustainability, guiding investment decisions, regulatory requirements, and stakeholder communication. Against this changing background, banking institutions play a critical role in driving environmental priorities. By way of capital allocation, credit policies, and risk management techniques, banking institutions can speed up or slow down low-carbon transitions. As D'Orazio and Popoyan (2018) stress, banking-sector prudential instruments are critical to green investment flows and decarbonization of portfolio finances. Arguing along similar lines, our study assumes that ESG performance of banking institutions should not be considered simply as a disclosure task, but rather as a competence central to driving financial competitiveness. Along similar lines, Naeem and Cankaya (2021) report a significant positive correlation between ESG scores and financial performance indicators, such as ROE and Tobin's Q, especially for developed economies. This challenge becomes critical for emerging economies like Turkey, where financial institutions are increasingly being asked to converge with international sustainability paradigms and national policy goals. This expectation has, by itself, induced detectable change in ESG performance measurement and disclosure patterns for Turkish banking institutions (Yılmaz & Demirtaş, 2024).

Various theoretical approaches assist in explaining why ESG is assuming increasing relevance for banking institutions. Stakeholder theory highlights that banking institutions should not restrict their responsibility to capital market-aligned shareholders but must intervene to examine a larger set of stakes, including investors, employees, customers, communities, and regulators, for purposes of perpetuating legitimacy and long-term value generation (Freeman et al., 2010; Hillman & Keim, 2001). According to legitimacy theory, banks' embrace ESG activities reflect reactions to external pressures and changing expectations for purposes of institutional legitimacy, implying conformity to widely accepted societal norms and values for institutions undergoing swift changes (Deegan, 2002; Suchman, 1995). As per signaling theory, consistent and clear ESG reports serve as trustworthy signals of a company's long-term focus, risk management capability, and endurance, particularly for institutions of institutional uncertainty where information is neither directly observable nor accessible (Connelly et al., 2010; Spence, 1973). Besides explaining why ESG assumes increasing relevance for banking institutions, these theories also comprise a conceptual framework for divulging ESG metrics as multidimensional gauges of organizational performance.

Over the last ten years, Turkey also issued a series of regulatory measures, chrono-analytically connectable, marking the sector's progression towards sustainability. In 2014, the Banking Regulation and Supervision Agency (BDDK) issued environmental and social risk management guides. A Green Deal Action Plan, pursuing conformity with the European Union's sustainability orientation, was issued by the Turkish government in 2021. A year afterward, a Sustainable Banking Strategic Plan was issued by the Banks Association of Turkey (TBB). Turkish banks, for their part, have started aligning their disclosures with new, global-emerging standards, such as the Corporate Sustainability Reporting Directive (CSRD) and the International Sustainability Standards Board (ISSB), which issued the IFRS S2 framework during 2023 and 2024, respectively. This regulatory development affected banks' reporting focus, as indicated by Şimşek and Şimşek (2025), revealing Turkish banks' growing focus on environmental and governance aspects, whereas a reduction of social themes is being reported, their reporting being significantly influenced by international sustainability paradigms and materiality screenings.

Despite gaining increasing global popularity, ESG disclosure remains isolated, relying on third-party ratings that lack consistency and transparency for many studies. This challenge is particularly prevalent in emerging economies, where the heterogeneity of methods and scarce data availability render meaningful benchmarking of a complex kind difficult to achieve. For Turkey's banking industry, the situation becomes even more severe due to a lack of empirical studies that combine both quantitative environmental indicators and qualitative disclosure data for multidimensional, institutionally comparable presentation purposes.

As Yılmaz and Demirtaş (2024) point out, despite the growth of ESG reporting efforts, few standardized and analytically consistent schemes are available for gauging the environmental performance of Turkish banks across different periods of time.

This study addresses this gap by introducing a standardized composite scoring model tailored to Turkish deposit banks. The model evaluates environmental performance across ten indicators, including CDP disclosure scores, greenhouse gas (GHG) emissions, water usage, and various efficiency-adjusted financial ratios. Using both direct and inverse normalization techniques, the model allows for systematic comparisons across institutions and over time.

Two main research questions guide the analysis:

- (1) How do selected Turkish banks compare in their environmental performance based on ESG indicators?
- (2) Can a composite ESG score, derived from normalized metrics, provide a reliable and consistent tool for comparative evaluation?

The contributions of this study are threefold. First, it introduces a transparent and replicable methodology that improves the accuracy and objectivity of ESG assessment in the banking sector. Second, it provides the first longitudinal dataset of normalized ESG scores for Turkish banks between 2022 and 2024, filling a critical empirical gap in the literature. Third, it lays the groundwork for integrating ESG metrics into institutional governance, regulatory reporting, and investment decision-making, offering practical guidance for risk committees, credit allocation processes, and asset-liability management practices.

By focusing on the intersection of methodological rigor and local relevance, the study offers both theoretical insights and practical tools to enhance the evaluation of sustainability in finance.

## 2. Literature review

With the increasing prominence of ESG factors across institutional and academic circles, a body of work has evolved that deals with the methods of measuring sustainability performance. There is a dominant strand in the debate that deals with the normalization and aggregation of cross-sectional indicators into composite measures of ESG, a process vital to the achievement of cross-sectional comparability and longitudinal consistency.

Normalization underlies the construction of ESG indices, particularly where multiple quantitative and qualitative measures are to be aggregated. Rani et al. (2025) suggested a two-stage procedure of normalization based on a hybrid decision support system implementing fuzzy logic for sustainability-based prioritization of financial services during a digital transformation context. It is indicative of increasingly advanced composite ESG scoring methodologies. Khan's (2024) work also indicated a new framework, a circular-ESG model, based on normalized sustainability coordinates (NSCs), which projects institutional activity into a Cartesian space representing environmental impacts and socio-economic impacts. The concept model determines how normalized indicators are capable of representing trends of sustainability spatially and dynamically.

These methodological developments resonate with more practice-oriented applications. Wójtowicz (2024) used a 36-item ESG disclosure index in large European cities, employing equal-weighted normalization to standardize transparency levels. The implications of the results demonstrate how normalization methods are transferable to applications that transcend corporate environments and extend into public administration. Ammari et al. (2022) constructed a Moroccan national SDG performance index utilizing min-max normalization and aggregation by geometry method, demonstrating how normalization methods allow comparable calculations across multidimensional indicators. Analogously, lo Storto and Evangelista (2023) compared EU logistic systems through DEA and composite weights based on entropy, presenting a methodological template for environmental efficiency across nations.

While several studies concentrate on environmental reporting and normalizing benchmarking of public or regional systems (Wójtowicz, 2024; Zabawa & Losiewicz-Dniestrzanska, 2024), fewer draw directly on these observations by extending them to bank-specific ESG metrics that are tailored to fit financial institutions (Chang et al., 2021; Rani et al., 2025). The thematic differentiation here has the potential to connect

firm-level assessment to sector-level frameworks in the case of banking.

Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) also became prominent normalization-adjacent measures in the application to ESG and efficiency analyses. Hou et al. (2019) and Grigoroudis and Petridis (2019) applied DEA models to develop environmental performance indexes, including desirable and undesirable outputs. Zhang and Wei (2024) applied a super-efficiency DEA-SBM model to investigate environmental regulation's impact on green economic efficiency, whereas Shair et al. (2021) applied DEA-Malmquist indexes to examine the total factor productivity of banks in Pakistan. These are evidence of normalization-driven efficiency measures applied to the domain of ESG. DEA-SBM models like those applied by Zhang and Wei (2024) differ from fuzzy MCDM models like Rani et al. (2025), but both make use of normalization to reduce dimensional disparity and to increase multi-criteria comparability.

Chang et al. (2021) used SFA and stochastic metafrontier analysis to evaluate the effects of ESG on Asian bank cost efficiency, noting regional differences. Abid and Goaid (2015) also used meta-frontier methods to standardize banks' performances across MENA nations by considering technological and environmental heterogeneity.

Normalization is not just a statistical requirement; in the context of ESG, it represents value-alignment tactics ingrained in sustainability measurement (Chiu, 2022; Khan, 2024). Zournatzidou (2024) used entropy-weighted TOPSIS to uncover how board independence influences ESG transparency, whereas Chiu (2022) criticized the EU's weak regulatory leadership in shaping metric development. These observations highlight the potential of uniform normalization in governance-related ESG measurements.

Zabawa and Losiewicz-Dniestrzanska (2024) have devised the Bank Ecologisation Index (BEI-2) to measure the environmental responsibility of Polish banks using standardization and composite scoring. These findings suggest that macroeconomic shocks such as the COVID-19 pandemic temporarily decouple environmental initiatives by firms from their financial outcomes. Although Beretta et al. (2023) focus on textual disclosure quality, they do not observe how normalized ESG intermediate scores mediate in the process, a discovery of particular pertinence by Ben Ali and Chouaibi (2024), who establish ESG practice parameters as a set of intermediate variables to mediate onto financial performance.

Climate risk and ESG factors increasingly shaping bank-level decisions, especially on lending. Fiordelisi et al. (2025) identified that climate stress test disclosure adversely affected European bank stock price, specifically those with branches in risky areas. Physical risk exposure was brought together with ESG signaling in their study. Ge et al. (2025) indicated that banks set a higher loan spread to those with larger climate risk, but that disclosure lowers the premium. Chupradit et al. (2021) and Chen et al. (2022) also indicated that green lending enhances intermediation margin and offsets default risk, not least in emerging markets.

These observations overlap with models of bank performance under distressed environments. Dar et al. (2021) and Kaur and Puri (2022) focused on the contribution of undesirable factors, such as non-performing assets (NPAs), in determining the efficiency. The fuzzy-DEA and dynamic models heavily depend on normalization to support qualitative distortions in financial sustainability. Ighravwe and Mashao (2019) also used a combination of BWM and extended TOPSIS under uncertain conditions to prioritize models of renewable energy finance, supporting the versatility of normalized MCDM models.

Normalisation also plays a crucial role in linking policy-making to ESG scoring. Dkhili and Ben Dhiab (2019) used panel data to map normalized environmental performance indicators to democratic and social policy indicators to establish the policy relevance of the ESG measures. McLaughlin et al. (2024) compared UNEP and World Bank sustainability metrics, attributing variations to different normalization methods. The critique supports global harmonisation of ESG index development to preclude mixed policy signals.

Lastly, structural and institutional elements remain of paramount importance for ESG transparency. Cosma et al. (2020) and Beretta et al. (2023) tested the role of the country's legal system and corporate board composition in shaping SDG disclosure. Rep et al. (2022) found

audit type and board size to play a material role in shaping disclosure quality. The three studies emphasize the necessity of harmonized, normalized reporting requirements. Ben Ali and Chouaibi (2024) added that ESG practices mediate the link between executive compensation and financial performance in MENA banks. By leveraging normalized ESG scores, they highlight how sustainability integration can align management incentives with long-term value creation.

Together, these studies illustrate a vibrant and methodologically diverse literature on ESG normalization. From multi-criteria decision-making to DEA and entropy-based techniques, the centrality of normalization underscores its critical role in enabling credible, comparable, and policy-relevant ESG measurement frameworks.

### 3. Methodology

This study adopts a quantitative design to evaluate the environmental sustainability performance of six Turkish banks from 2022 to 2024. Data were manually extracted from publicly available integrated annual reports, covering ten ESG indicators, including CDP scores, emissions, resource use, and efficiency metrics. To ensure comparability across institutions and years, all indicators were normalized using the min-max scaling. A composite ESG score was computed for each bank by aggregating standardized values, enabling objective, transparent, and consistent cross-institutional performance assessment within the Turkish banking sector.

#### 3.1. Data source and collection process

The dataset used in this study was constructed for six major deposit banks (AKBNK, ALBRK, GARAN, HALKB, VAKBN, and YKBNK) operating in Turkey, which had complete ESG data available for the years 2022, 2023, and 2024. Although the initial study universe included ten banks, only these six met the data completeness criteria for the entire period analyzed.

The data were manually collected by the researcher through a detailed review of the Integrated Annual Reports published on the Public Disclosure Platform (KAP). For each bank, CDP scores, environmental performance indicators (e.g., water consumption, carbon emissions), and environmental efficiency ratios were extracted and organized into tables by year.

#### 3.2. Data source and collection process

The initial scope of the study comprised ten major deposit banks in Turkey. However, due to inconsistencies in sustainability reporting practices, certain ESG indicators were not reported consistently across all years for some banks. In particular, qualitative indicators such as the CDP Climate Change Score and CDP Water Security Score were not disclosed continuously; for some banks, these were only available for select years. The lack of temporal consistency in ESG disclosures undermines the reliability of longitudinal and comparative analysis, as significant data gaps and reporting heterogeneity reduce comparability and introduce measurement bias (Caprioli et al., 2024; Sahin et al., 2021). Therefore, banks with incomplete year-specific CDP data were excluded from the analysis.

Additionally, a specific case emanated in Scope 2 greenhouse gas (GHG) emission reporting, which covers indirect energy use emissions. Some of the engrossed banks decreased Scope 2 emissions to zero by procuring renewable energy and energy efficiency initiatives. Such zeros are not missing data indicators but are somewhat intentional environmental shifts, such as renewable energy procurement and decarbonization initiatives by banks, an instrument matching changing global best practices, greening the finance system, and GHG report standardization (Glasgow Financial Alliance for Net Zero, 2024; Network for Greening the Financial System, 2024). The huge variation of scope, methodology, and quality of environment, social, and governance (ESG) reporting across institutions is a significant issue, rendering it difficult to allow for equitable benchmarking since disjointed disclosure frameworks compromise reliability and comparability (Berg et al., 2022; Cort & Esty, 2020).

In order to tackle this challenge, a composite environmental effect measure was constructed. Total carbon release was calculated by the addition of Scope 1, Scope 2, and Scope 3 emissions, by bank, by year.

This composite measure, known as Total GHG Emissions, entered analysis as follows:

$$\text{Total Emissions}_{t,b} = \text{Scope } 1_{t,b} + \text{Scope } 2_{t,b} + \text{Scope } 3_{t,b} \quad (1)$$

This value of consolidated emissions reflects the totality of environmental impacts of carbon arising from the banks' direct and indirect activities. Ensuring that comparisons are possible in ESG evaluations necessitates normalization techniques that minimize the effects of scale and unit differences to enhance methodological uniformity and allow valid intersituational comparisons (Singhania & Saini, 2021; Tamimi & Sebastianelli, 2017).

Consequently, the sample scope of the analysis consists of six banks, AKBNK, ALBRK, GARAN, HALKB, VAKBN, and YKBNK, that provided complete data on each of the chosen indicators over the years under investigation. The ESG dataset built here is methodologically solid and adequate, reflecting scholarship's calls to prioritize complete and comparable environmental and social disclosures to make sustainability evaluations causally valid and theoretically informed in nature (Fatemi et al., 2018; Hussain et al., 2018).

### 3.3. Selection of esg indicators

ESG indicators have been selected based on their environmental relevance, data accessibility, and scalability across banks and over time. Both qualitative indicators (CDP Climate Change Score and Water Security Score) and quantitative indicators (Water Consumption, Total GHG Emissions, Net Profit per Emissions, Loans per Emissions, and Deposits per Emissions) have been selected to provide a multi-dimensional and comparable ESG evaluation for the period 2022–2024.

The ten chosen ESG indicators are shown in Table 1 with a description of how each metric is interpreted (i.e., whether a higher or a lower value is desirable) and type of normalization used. Direct normalization is used when higher values indicate better performance, whereas inverse normalization is applied for metrics where lower values are considered more favorable. This standardization ensures methodological consistency across banks and years in the composite ESG score calculation.

As shown in Table 1, the selected indicators reflect both strategic and operational aspects of environmental performance. Disclosure-focused metrics, such as CDP scores, are complemented by efficiency ratios that are adjusted for emissions and resource use. While Water Consumption and GHG Emissions are normalized inversely due to their negative environmental impact, the remaining indicators use direct normalization, reflecting improvements in sustainability outcomes. This balanced structure ensures comparability across banks and consistency over time.

**TABLE 1 |** ESG indicators, their interpretation direction, and applied normalization method

Indicator	Interpretation Direction	Normalization Method
CDP – Climate Change Score	Higher values indicate better performance	Direct Normalization
CDP – Water Security Score	Higher values indicate better performance	Direct Normalization
Water Consumption (m <sup>3</sup> )	Lower values indicate better performance	Inverse Normalization
Total GHG Emissions (ton CO <sub>2</sub> e)	Lower values indicate better performance	Inverse Normalization
Net Profit / Water Consumption	Higher values indicate better performance	Direct Normalization
Net Profit / Emissions	Higher values indicate better performance	Direct Normalization
Loans / Water Consumption	Higher values indicate better performance	Direct Normalization
Loans / Emissions	Higher values indicate better performance	Direct Normalization
Deposit / Water Consumption	Higher values indicate better performance	Direct Normalization
Deposits / Emissions	Higher values indicate better performance	Direct Normalization

**Note:** Water consumption is measured in cubic meters (m<sup>3</sup>); GHG emissions are reported in tons of CO<sub>2</sub>-equivalent (tCO<sub>2</sub>e); financial indicators (net profit, total loans, total deposits) are reported in thousand Turkish Lira (₺), based on publicly disclosed annual reports of each bank.

Table 2 introduces a cross-reference between the ESG indicators employed in this study and the requirements outlined in two major regulatory disclosure frameworks: the IFRS S2 Climate-related Disclosures (issued by the ISSB) and the European Sustainability Reporting Standards (ESRS), specifically E1 and E3. The goal of this crosswalk is to ensure that the selected indicators are not only academically grounded but also aligned with internationally recognized reporting expectations.

**TABLE 2 |** Crosswalk table: alignment between esg indicators and regulatory frameworks

ESG Indicator	IFRS S2 – Climate-related Disclosures	ESRS E1/E3 – Environmental Standards
Scope 1 Emissions	S2-14: GHG emissions by scope	E1-6: Gross GHG emissions (paragraph 44–46)
Scope 2 Emissions	S2-14: GHG emissions by scope	E1-6: Gross GHG emissions (paragraph 44–46)
Scope 3 Emissions	S2-14: GHG emissions by scope	E1-6: Gross GHG emissions (paragraph 44–46)
Total GHG Emissions	S2-14: Total GHG emissions disclosure	E1-6: Total GHG emissions – consolidated
Water Consumption (m <sup>3</sup> )	Not directly listed	E3-5 to E3-8: Water consumption, withdrawal, discharge
CDP Climate Change Scr.	S2-5: Climate-related risk governance	E1-1: Transition risk management
CDP Water Security Score	Only climate in IFRS S2	E3-6/E3-7: Water-related risk and impact management
Net Profit / Emissions	S2-14 + S2-2(b)(iii): GHG intensity per revenue	E1-6(c): GHG emissions intensity relative to financial metrics
Loans / Emissions	S2-2(c): Asset exposure to climate risk	E1-6(d): Exposure-based GHG metrics linked to business act.
Deposits / Emissions	S2-2(b)(iii) + S2-14(d): GHG intensity measure	E1-6(d): Emission performance linked to financial operations
Net Profit / Water Use	Not directly in S2	E3-6: Water efficiency and economic linkage
Loans / Water Use	Not directly in S2	E3-7: Water performance by segment or activity
Deposits / Water Use	Not directly in S2	E3-7: Water use intensity or efficiency indicators

Each indicator has been mapped to corresponding provisions in both frameworks, reflecting their regulatory relevance. For instance, Scope 1, Scope 2, and Scope 3 emissions are addressed in IFRS S2 under provision S2-14 and correspond to paragraphs 44 to 46 of ESRS E1-6. Likewise, performance metrics such as emissions-adjusted profitability or loan allocations are connected to GHG intensity and exposure-based metrics emphasized in both standards. Although IFRS S2 places limited emphasis on water-related indicators, ESRS E3 offers detailed requirements on water consumption, withdrawal, and discharge. This correspondence reinforces the methodological robustness of the study and supports the compatibility of the ESG scoring model with evolving sustainability reporting obligations.

### 3.4. Quantification of qualitative data

The letter-based ESG assessment scores provided by CDP (Carbon Disclosure Project) were converted into numerical values according to the scale presented in Table 3. This conversion enables the inclusion of qualitative scores in quantitative ESG assessments.

**TABLE 3 |** Conversion of cdp letter grades to numeric scores

CDP Grade	Numeric Equivalent
A	5,00
A–	4,50
B+	4,00
B	3,50
B–	3,00
C	2,50
C–	2,00
D	1,50
D–	1,00

**Note:** CDP does not publish an official letter-to-number conversion table in its scoring methodology documents; this mapping is researcher defined in our work.

The letter grades were taken directly as reported in the official CDP records and mapped to their corresponding numeric scores based on a predefined conversion scale. No further cleaning or reformatting was applied.

### 3.5. Indicator Normalization

In order to ensure comparability among indicators that differ in scale and units, all ESG indicators used in this study were normalized within a range of 0 to 1. This transformation allows the combination of heterogeneous variables into a single composite ESG score while preserving the relative performance of each bank.

The direction of interpretation for each indicator determined the type of normalization method applied. Specifically, two different normalization approaches were used based on whether higher or lower values indicated better performance.

#### 3.5.1. Direct normalization

Direct (min-max) normalization was applied to indicators where higher values indicate better ESG performance. This transformation rescales the data linearly between 0 and 1, according to the following formula:

$$Normalized\ Score_{b,i} = \frac{x_{b,i} - \min(x_i)}{\max(x_i) - \min(x_i)} \quad (2)$$

Where:

$x_{b,i}$  is the original value for bank  $b$  on indicator  $i$ ,

$\min(x_i)$  and  $\max(x_i)$  are the minimum and maximum values of indicator  $i$  across all banks for a given year.

Indicators for which higher numerical values reflect stronger ESG outcomes were normalized using the min-max method. This includes both qualitative dimensions, such as the CDP Climate Change and Water Security Scores, representing environmental strategy and risk governance, as well as quantitative ratios like Net Profit per Emissions, Loans per Emissions, and Deposits per Emissions, which signal operational and environmental efficiency. The normalization ensures that all such indicators are scaled proportionally within a [0–1] range, facilitating fair comparison across banks.

#### 3.5.2. Inverse normalization

This method is used when lower values are indicative of better ESG performance. The corresponding formula is:

$$Normalized\ Score_{b,i} = \frac{\max(x_i) - x_{b,i}}{\max(x_i) - \min(x_i)} \quad (3)$$

Inverse normalization was used with indicators where original values that are lower imply stronger ESG performance. The method was applied specifically to Water Consumption ( $m^3$ ) and Total GHG Emissions (ton CO<sub>2</sub>e), where decreased values of these represent greater environmental efficiency and reduced ecological footprint. Through the application of these normalization methods, the research ensures that greater normalized scores always represent superior ESG performance, regardless of original scale or direction of indicators. Standardization of methodology is crucial in developing credible and unbiased ESG scores because consistency in treatment of indicators and normalization minimizes subjective distortions and allows comparability over time (Busch et al., 2016; Tamimi & Sebastianelli, 2017).

### 3.6. Composite ESG Score Construction

To evaluate the overall ESG performance of each bank in a stable and holistic way, a composite ESG score was built by aggregating the normalized values of selected indicators. In contrast to the conventional method of calculating individual year scores, in the current work, a combined composite ESG score across a bank is calculated by first taking the average of each raw measure over the 2022, 2023, and 2024 years. These averages are then normalized (by direct or inverse normalization based on the direction of the indicator) to arrive at the composite score. All normalized indicators are on a 0 to 1 scale,

making them comparable across various metrics of different units and distributions. The final ESG score for each bank is computed as the arithmetic mean of the ten normalized indicator values, as shown below:

$$ESG\ Score_{b,t} = \frac{1}{10} \sum_{i=1}^{10} Normalized\ Score_{b,i,t} \quad (4)$$

An equal weighting across indicators is used to maintain objectivity and exclude subjective prioritization. Averaging over several years of ESG indicators reduces short-run noise and captures underlying trends in sustainability better, a procedure widely used to minimize signal-to-noise ratio, counteract ESG rating uncertainty, and make evaluative comparisons clearer (Avramov et al., 2022; Chatterji et al., 2009).

### 3.7. ESG score interpretation and ranking

The composite ESG scores calculated for each bank and year were interpreted on a [0–1] scale, where higher values reflect stronger sustainability performance. Scores approaching 1.00 indicate consistently high performance across all ESG indicators, while lower scores reveal shortcomings in one or more environmental or efficiency dimensions.

For ease of interpretation, the normalized scores were applied to rank the six banks chosen in order of their overall average operational ESG performance for the 2022–2024 period. The rankings were from highest to lowest based on descending ESG score value, and the top-ranked bank each year was the one with the highest value.

With this approach, it is possible to compare banks to each other and find which of their ESG are best-in-class. It also catches year-over-year deviations of bank-specific performance, as well as shifts in the relative sustainability rankings of the banks being analyzed.

Final rankings on ten selected indicators are a proportionate mix of environmental care and business efficiency. ESG-based rankings also serve as a comparator of sustainability performance, providing firms with a mechanism for identifying areas of excellence as well as areas for improvement, consistent with research on the strategic potential of ESG disclosure for generating firm performance differentiation (Amel-Zadeh & Serafeim, 2018; Baldini et al., 2018).

### 3.8. Methodological limitations and opportunities for future enhancement

Although the study employs a transparent and replicable method based on descriptive statistics and normalization, it does not incorporate advanced tools such as machine learning or multivariate analysis. This constraint mirrors typical difficulties of ESG studies for emerging market economies, for which data elegance and regulatory sophistication are still constrained (Singhania & Saini, 2021). Subsequent research may apply similar instruments to discover patterns, enhance predictivity, and model policy effects.

## 4. Findings

This section presents the analytical results based on ESG indicators within the study's methodological framework. The analysis follows two steps: first, descriptive statistics are used to summarize trends and differences across banks; second, a normalization process transforms raw data into comparable values. This enables the construction of a composite ESG index, supporting both cross-sectional and longitudinal evaluations of environmental performance in the Turkish banking sector.

### 4.1. Descriptive statistics of ESG indicators (2022–2024)

In this part, the empirical results of the research based on the selected and outlined ESG indicators are presented. For each of the indicators, scores for 2022, 2023, and 2024 were calculated, along with descriptive statistics in the form of mean, minimum, maximum, and standard deviation values. The results are expected to offer a comparative measurement of six large-scale Turkish banks' environmental performances. Each subheading contains pertinent tables along with explanations to ease comprehension and identify tendencies in the performances.

**TABLE 4 | Cdp – climate change score (ccs) summary**

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	3,0	3,5	5,0	3,8	3,0	5,0	1,04
ALBRK	3,5	3,0	2,5	2,9	2,5	3,5	0,55
GARAN	5,0	3,0	5,0	4,7	4,5	5,0	0,87
HALKB	4,5	4,5	5,0	4,7	4,5	5,0	0,29
VAKBN	3,0	5,0	5,0	4,3	3,5	5,0	1,15
YKBNK	4,5	5,0	5,0	4,8	3,5	5,0	0,29

Table 4 displays the Climate Change Scores of the chosen Turkish banks from 2022 to 2024, which reflect the banks' climate-related risk management and a measure of the quality of their climate-related disclosures. The scores, initially calculated from CDP letter grades, were then converted into a numerical scale to facilitate statistical analysis. GARAN, HALKB, and YKBNK consistently exhibited superior performance, with average scores ranging above 4.5 over the three years. ALBRK's below-average mean score of 2.9, on the other hand, signifies poor climate risk transparency or immature reporting practices. The moderate standard deviation figures imply fluctuation, with the highest variability seen in VAKBN. The persistent variation in climate risk maturity among Turkish banks also mirrors greater inconsistencies in the application of best practices in ESG reporting that have been cited in similar global contexts. The value of implementing harmonized structures to regulate the framework of ESG disclosures is demonstrated by the variations. This feature has been argued by the Task Force on Climate-related Financial Disclosures (TCFD) and quantitatively corroborated by studies that have posited regulatory standardization to enhance compatibility and transparency in climate-related disclosures (Amel-Zadeh & Serafeim, 2018; Baldini et al., 2018).

**TABLE 5 | Cdp – water security score (wsc) summary (2022–2024)**

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	3,0	3,5	5,0	3,8	3,0	5,0	1,04
ALBRK	3,5	3,0	2,5	3,0	2,5	3,5	0,50
GARAN	4,5	4,5	5,0	4,7	4,5	5,0	0,29
HALKB	4,5	5,0	4,5	4,7	4,5	5,0	0,29
VAKBN	3,0	4,5	5,0	4,2	3,0	5,0	1,04
YKBNK	3,5	5,0	5,0	4,5	3,5	5,0	0,87

Table 5 presents the CDP Water Security Scores for each bank from 2022 to 2024, providing insight into how institutions disclose and address water-based risks. The scores reflect institutions' capacity to measure water risks, set reduction targets, and build resilience measures. GARAN and HALKB also showed a stable record of scores each year, which indicates sustained activities of water stewardship activities. ALBRK shows a trend of decrease by having a lower average of 3.0, which may reflect weakly developed water risk management and weak strategic connection, traits usually possessed by those banks having immature sustainability schemes, as mentioned in prior studies about ESG disclosure quality and organizational embedding (KPMG, 2020; Singh et al., 2022). The standard deviation figures are relatively low across banks, suggesting a consistent level of performance and ensuring uniform reporting across the time span observed. These scores are normalized later to make them comparable to the other dimensions of ESG.

**TABLE 6 | Water consumption (WC) summary statistics (2022–2024)**

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	184.538	170.542	168.335	174.472	168.335	184.538	8.787
ALBRK	44.772	32.307	45.947	41.009	32.307	45.947	7.559
GARAN	233.000	223.000	252.000	236.000	223.000	252.000	14.731
HALKB	215.088	210.357	267.025	230.823	210.357	267.025	31.441
VAKBN	215.176	255.275	273.169	248.540	217.176	273.169	28.598
YKBNK	215.375	175.232	214.026	201.544	175.232	215.375	22.797

**Note:** Water consumption is reported in cubic meters ( $m^3$ ) and represents the annual water usage by each bank over the 2022–2024 period.

Table 6 Water Consumption Summary Statistics (2022–2024) reports the annual water usage (in  $m^3$ ) of each bank over a three-year period. The table presents the mean, the lowest value, the highest value, and the standard deviation, providing insights into average consumption levels and year-on-year variability. The lowest average water consumption is that of ALBRK, whereas the highest is that of VAKBN. Banks with larger fluctuations in water consumption are indicated by institutions such as HALKB and VAKBN, indicating irregular environmental resource control. The variability could simply be a pointer to the lack of institutionally embedded water efficiency policies, a situation often indicated in those institutions that do not have formalized mechanisms for monitoring sustainability performance (Bouten et al., 2011; Dienes et al., 2016). The measure will subsequently be normalized against, where a lower value represents a greater environmental efficiency.

**TABLE 7 | Total GHG emissions (GHGE) summary statistics (2022–2024)**

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	41.860	21.903	22.310	28.691	21.903	41.860	11.407
ALBRK	10.071	12.352	13.224	11.882	10.071	13.224	1.628
GARAN	19.392	29.518	30.721	26.544	19.392	30.721	6.223
HALKB	68.604	63.975	74.696	69.092	63.975	74.696	5.377
VAKBN	15.368	15.933	16.977	16.093	15.368	16.977	816
YKBNK	55.068	59.680	77.112	63.953	55.068	77.112	11.627

**Methodological Note:** Several banks (GARAN, AKBNK, İşbank) reported Scope 2 greenhouse gas emissions as "0" because their electricity consumption is either fully sourced from renewable energy or backed by I REC (International Renewable Energy Certificate) purchases. These zero values represent actual decarbonization measures rather than missing or unreported data. Emissions are reported in tons of  $CO_2$ -equivalent ( $ton CO_2e$ ), as declared in each bank's official sustainability reports (2022–2024).

Below is a summary of the overall greenhouse gas (GHG) emissions (Scope 1 + Scope 2 + Scope 3) reported by each bank across the 2022–2024 timeframe. The "Mean Score" value reflects the average annual emission, whereas the minimum, maximum, and standard deviation values represent the variation of the emission over time. High emission levels are seen in HALKB and YKBNK, reflecting a larger environmental footprint and possibly limited decarbonization measures in the operational realm. High emission intensity within financial institutions tends to reflect a weak embedding of low-carbon policies in core businesses, as exemplified by studies that identify the slow embracing of climate mitigation imperatives by the banking industry (Busch, 2010; Weber, 2014). Conversely, ALBRK has the lowest average emission levels, reflecting relatively steady annual figures. These values form a crucial input to inverse normalization in ESG scoring.

**TABLE 8 | Net profit per water consumption ( $m^3$ ) (np/wc) summary statistics (2022–2024)**

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	325	390	252	322	252	390	69
ALBRK	30	106	94	77	30	106	41
GARAN	250	387	362	333	250	387	73
HALKB	71	48	57	59	48	71	12
VAKBN	111	98	148	119	98	148	26
YKBNK	245	388	136	256	136	388	126

**Note:** Net profit is reported in thousand Turkish Lira (₺); water consumption is measured in cubic meters ( $m^3$ ). The ratio (np/wc) reflects environmental efficiency in terms of financial return per unit of water consumed.

Table 8 presents descriptive statistics for the environmental efficiency indicator, which represents the ratio of net profit to water consumption for each bank over the 2022–2024 period. Higher values in this ratio suggest stronger performance in terms of generating financial returns while utilizing fewer water resources. The statistics include annual data, mean values over the three-year period, as well as the minimum, maximum, and standard deviation values to reflect both central tendency and variability. Among the banks, GARAN and YKBNK demonstrated the highest average profitability per unit of water consumed, which can be interpreted as a relatively efficient use of environmental resources.

This aligns with the growing emphasis in sustainable finance literature on resource-based financial productivity, where firms achieving higher returns with lower environmental input are viewed as more sustainable (Branco & Rodrigues, 2008; Scholtens, 2009). In contrast, HALKB reported consistently lower ratios, suggesting room for improvement in aligning profitability with sustainable water use.

**TABLE 9 |** Net profit to total emissions (np/te) summary statistics (2022–2024)

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	1.434	3.036	1.899	2.123	1.434	3.036	824
ALBRK	136	278	326	247	136	326	99
GARAN	3.006	2.926	2.970	2.967	2.926	3.006	40
HALKB	223	158	202	194	158	223	33
VAKBN	1.563	1.572	2.378	1.838	1.563	2.378	468
YKBNK	958	1.140	376	825	376	1.140	399

**Note:** Net profit is reported in thousand Turkish Lira (₺); total emissions are measured in tons of CO<sub>2</sub>-equivalent (tCO<sub>2</sub>e). The ratio (np/te) represents environmental economic efficiency in terms of profitability per unit of carbon emissions.

Table 9 presents the descriptive statistics for the Net Profit to Total Emissions ratio across the selected banks for the years 2022 through 2024. This metric is indicative of environmental-economic efficiency, assessing how effectively banks generate profit relative to their carbon footprint. Higher values imply greater profitability per unit of CO<sub>2</sub>e emitted, reflecting stronger performance in sustainable operations. The results reveal that GARAN consistently outperforms other banks with a high average Net Profit to Emissions ratio, reflecting stronger environmental-economic efficiency. Prior research emphasizes that such performance is indicative of institutions that have effectively embedded carbon-conscious strategies into profitability models, a trend observed among banks with advanced ESG integration and climate risk management practices (Busch, 2010; Weber, 2014). In contrast, ALBRK and HALKB reported lower values, suggesting less favorable alignment between profitability and emissions control. Standard deviation figures highlight the variability in performance, with ALBRK and YKBNK showing greater dispersion compared to peers.

**TABLE 10 |** Loans per water consumption (l/wc) summary statistics (2022–2024)

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	3.339	5.641	8.174	5.718	3.339	8.174	2.419
ALBRK	1.666	3.238	3.717	2.874	1.666	3.717	1.073
GARAN	3.267	5.462	7.049	5.259	3.267	7.049	1.899
HALKB	4.790	7.856	5.474	6.040	4.790	7.856	1.609
VAKBN	4.391	5.951	7.490	5.944	4.391	7.490	1.549
YKBNK	2.917	5.407	6.094	4.806	2.917	6.094	1.672

**Note:** Loan volume is measured in thousand Turkish Lira (₺), and water consumption is measured in cubic meters (m<sup>3</sup>). The indicator reflects environmental efficiency in credit extension relative to water use.

Table 10 exhibits the summary statistics of the “Loans per Water Consumption” measure that addresses the amount of bank lending compared to overall water consumption over 2022–2024. The ratio represents a measure of environmental efficiency as it captures the ability of each bank to make the most out of water resources used in credit generation. The greater the value, the better the water efficiency per unit of finance produced. AKBNK had the highest average ratio of 5.718, followed by GARAN with 5.259, denoting relatively robust environmental-financial productivity. This supports earlier evidence that banks that have introduced environmental efficiency measurement into credit extension tend to register improved performance under sustainability-adjusted financial measures (Jeucken, 2001; Scholtens, 2009). ALBRK, on the other hand, registered the lowest average of 2.874, which calls for improvement in water-resource efficiency. The standard deviation figures also reflect the range of performances over the years, with the highest range registered by AKBNK. The results provide evidence of the comparative integration of water efficiency in the credit extension practices of Turkish banks.

**TABLE 11 |** Loans per total emissions (t/te) summary statistics (2022–2024)

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	14.718	43.925	61.676	40.106	14.718	61.676	23.711
ALBRK	7.407	8.470	12.915	9.597	7.407	12.915	2.922
GARAN	39.248	41.262	57.822	46.111	39.248	57.822	10.192
HALKB	15.018	25.831	19.569	20.139	15.018	25.831	5.429
VAKBN	62.059	95.344	20.520	92.641	62.059	120.520	29.324
YKBNK	11.407	15.877	16.913	14.733	11.407	16.913	2.926

**Note:** Loan volume is measured in thousand Turkish Lira (₺), and total emissions are reported in tons of CO<sub>2</sub>-equivalent (ton CO<sub>2</sub>e). The indicator reflects the environmental efficiency of credit allocation relative to carbon footprint.

Table 11 also shows the average, minimum, maximum, and standard deviation of the ‘Loans per Total Emissions’ ratio during the 2022–2024 periods. The indicator embodies the amount of loan disbursement per CO<sub>2</sub>e emission ton, and serves as a proxy of the environmental efficiency of lending. A higher value signifies a higher financial output with less environmental implication. The banks are not constant, and VAKBN shows the highest average ratio, reflecting its great low-emission loan-granting efficiency. The same outcome is consistent with investigations that emphasize banking institutions that provide green credit disbursement and carbon-inclusive loan-granting policy showed higher environmental loan-granting efficiency (Cui et al., 2018; Weber, 2014). ALBRK and YKBNK are poor efficiency holders. The outcomes are consistent with similar evaluations of green loan-granting policies across institutions.

**TABLE 12 |** Deposits per water consumption (d/wc) summary statistics (2022–2024)

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	3.910	7.581	9.699	7.063	3.910	9.699	2.929
ALBRK	2.517	5.008	4.457	3.994	2.517	5.008	1.309
GARAN	3.900	71.771	8.549	28.073	3.900	71.771	37.915
HALKB	49.286	8.903	8.920	22.370	8.903	49.286	23.311
VAKBN	5.193	7.685	9.290	7.389	5.193	9.290	2.065
YKBNK	3.276	6.328	6.421	5.342	3.276	6.421	1.790

**Note:** Deposit volume is reported in thousand Turkish Lira (₺), and water consumption is measured in cubic meters (m<sup>3</sup>). The indicator reflects environmental efficiency by evaluating how effectively water resources are used to mobilize deposit volumes.

Below is a summary of the descriptive statistics of the “Deposits per Water Consumption” ratio of each bank from 2022 to 2024. The measure quantifies the banks’ efficiency in using water compared to deposit volumes, which measures the sustainability of levels of operation. The larger the value, the greater the mobilization of deposits with decreased water consumption, signifying better environmental efficiency. GARAN has a significantly large Maximum due to a 2023 outlier, whereas HALKB has variability. These results reveal significant inter-bank disparities in environmental resource management, reflecting differences in institutional sustainability commitments and operational efficiency strategies. Prior studies emphasize that such disparities often stem from the absence of standardized environmental performance benchmarks and varying levels of ESG integration across banks (Bouten et al., 2011; Dienes et al., 2016).

**TABLE 13 |** Deposits per total emissions (d/te) summary statistics (2022–2024)

Bank	2022	2023	2024	Mean Score	Min	Max	Std. Dev
AKBNK	17.238	59.029	73.178	49.815	17.238	73.178	29.086
ALBRK	11.188	13.100	15.484	13.257	11.188	15.484	2.152
GARAN	46.862	542.209	70.126	219.732	46.862	542.209	279.515
HALKB	154.523	29.275	31.886	71.895	29.275	154.523	71.570
VAKBN	73.380	123.126	149.484	115.330	73.380	149.484	38.646
YKBNK	12.811	18.581	17.822	16.404	12.811	18.581	3.135

**Note:** Deposits are reported in thousand Turkish Lira (₺), and emissions are expressed in tons of CO<sub>2</sub>-equivalent (ton CO<sub>2</sub>e). The indicator captures environmental efficiency by quantifying deposit mobilization relative to carbon output; higher values indicate better sustainability performance.

Table 13 presents the annual and average ratios of deposits to total greenhouse gas emissions for six Turkish banks over the 2022–2024 period. A higher ratio implies greater environmental efficiency in deposit mobilization relative to carbon output. GARAN and VAKBN report particularly high mean values, suggesting stronger environmental productivity per unit of emissions. However, the high standard deviation, especially for GARAN and HALKB, reflects substantial volatility and potential anomalies in emissions reporting or deposit scale. Such inconsistencies are often linked to the lack of harmonized carbon accounting methodologies and limited third-party verification, which remain key challenges in ESG reporting by financial institutions (Busch, 2010; Weber, 2014).

## 4.2. Normalization process and scaled indicator construction

To ensure comparability across ESG indicators with different units, scales, and interpretation directions, a normalization process was implemented. This step is essential for integrating heterogeneous environmental performance metrics into a composite ESG score, where each indicator contributes equally to the final evaluation. Two normalization procedures were implemented according to each indicator's interpretive orientation: direct normalization for those where better performance is indicated by greater values, and inverse normalization, where smaller values are indicative of increased efficiency or sustainability. Normalization converts all raw values to a uniform 0-to-1 range, making it possible to aggregate them in a way that is not biased. Below, example applications of each normalization measure are illustrated in detail, preceded by the normalized scores of all indicators.

### 4.2.1 Direct normalization: cdp – climate change score

In this subsection, we illustrate the application of direct normalization using the CDP – Climate Change Score as a representative indicator. Direct normalization is appropriate when higher raw scores reflect better environmental or sustainability performance. This transformation ensures that all indicator values fall within a uniform [0–1] scale, facilitating meaningful aggregation across diverse ESG metrics.

To illustrate the application of direct normalization, the CDP – Climate Change Score was selected as a representative indicator. This indicator is qualitative in nature, with numeric equivalents assigned to letter-based scores as outlined in the methodology. The mean score for each bank over the 2022–2024 period was computed and used as the basis for normalization.

The raw three-year average scores for each bank are shown in Table 13.

**TABLE 14 |** Average cdp – climate change scores of Turkish banks (2022–2024)

Bank	Mean Score
AKBNK	3,8
ALBRK	2,9
GARAN	4,7
HALKB	4,7
VAKBN	4,3
YKBNK	4,8

*Note:* CDP – Climate Change Score is a qualitative indicator provided by the Carbon Disclosure Project and converted to numeric values on a scale of 0–5, with higher values representing stronger climate disclosure performance. The reported mean scores are based on converted values for the 2022–2024 period.

As shown in Table 14, YKBNK had the highest three-year average CDP Climate Change score (4.8), followed closely by HALKB and GARAN (4.7 each). On the lower end, ALBRK scored 2.9, indicating weaker climate disclosure performance relative to peers.

Using the min-max normalization formula, the minimum value in this dataset is 2.9 (ALBRK), and the maximum is 4.8 (YKBNK). Applying the direct normalization equation:

$$Normalized\ Score_{b,i} = \frac{x_{b,i} - \min(x_i)}{\max(x_i) - \min(x_i)} \quad (5)$$

The normalized values for each bank are calculated as shown in Table 14.

$$Akbank = \frac{3.8 - 2.9}{4.8 - 2.9} = 0,48$$

**TABLE 15 |** Normalized scores of climate change indicator based on three-year averages

Bank	Mean Score	Normalized Scores
AKBNK	3,8	0,48
ALBRK	2,9	0,00
GARAN	4,7	0,92
HALKB	4,7	0,92
VAKBN	4,3	0,74
YKBNK	4,8	1,00

*Note:* The normalized scores are derived using the min-max method applied to average CDP Climate Change scores over the 2022–2024 period. The original scores are qualitative assessments translated into numeric equivalents, where higher values indicate stronger climate-related disclosure and governance.

As shown in Table 15, YKBNK achieved the highest normalized score (1.00), indicating leading performance in climate change disclosure. In contrast, ALBRK scored the lowest (0.00), reflecting room for improvement in climate-related reporting. Other banks, such as GARAN and HALKB, scored similarly high (0.92), suggesting a strong cluster of performance among major private and state-owned banks.

### 4.2.2 Inverse normalization: water consumption (m<sup>3</sup>)

This subsection presents the inverse normalization process, which is applied when lower indicator values denote better environmental performance. Unlike direct normalization, inverse normalization ensures that lower raw values translate into higher normalized scores, thereby aligning all metrics on a common interpretive direction, where 1 represents optimal ESG performance.

Water consumption (measured in cubic meters) was selected as the representative inverse-normalized indicator. Since minimizing water use is a sign of environmental efficiency, this metric requires transformation through the inverse formula to make it comparable with directly normalized indicators.

The three-year average water consumption values for the banks are as follows:

**TABLE 16 |** Average water consumption of Turkish banks (2022–2024)

Bank	Mean Score
AKBNK	174.472
ALBRK	41.009
GARAN	236.000
HALKB	230.823
VAKBN	248.540
YKBNK	201.544

*Note:* Water consumption is measured in cubic meters (m<sup>3</sup>) and represents the three-year average for each bank between 2022 and 2024

As shown in Table 16, ALBRK demonstrates the lowest average water consumption (41.009 m<sup>3</sup>), while VAKBN consumes the most water on average (248.540 m<sup>3</sup>), indicating significant variation in resource use across the sector. In this dataset, the minimum value is 41,009 (ALBRK), and the maximum is 248,540 (VAKBN). The inverse normalization formula is applied as follows:

$$Normalized\ Score_{b,i} = \frac{\max(x_i) - x_{b,i}}{\max(x_i) - \min(x_i)} \quad (6)$$

$$For\ example,\ for\ AKBNK = \frac{248.540 - 174.472}{248.540 - 41.009} = 0,357$$

**TABLE 17 |** Normalized scores of water consumption indicator based on three-year averages

Bank	Mean Score	Normalized Scores
AKBNK	174.472	0,36
ALBRK	41.009	1,00
GARAN	236.000	0,06
HALKB	230.823	0,09
VAKBN	248.540	0,00
YKBNK	201.544	0,23

**Note:** Water consumption values are reported in cubic meters (m<sup>3</sup>), and the normalized scores are calculated using inverse normalization. In this approach, lower raw values (indicating less water use) translate into higher normalized scores, reflecting better environmental performance in resource efficiency

Normalized scores resulting from the ensuing demonstrate that ALBRK is superior to a number of banks based on water-use efficiency, posting the highest normalized value of 1.000, whereas VAKBN has the lowest value of 0.00 owing to its comparatively large average consumption. The method provides a logical interpretation across all dimensions of the ESG and allows integration into the composite scoring model.

### 4.3. Composite ESG score calculation

To evaluate the overall ESG performance of each bank in a unified and transparent manner, the normalized values of ten ESG indicators were aggregated to compute a composite score. The score of each bank is the arithmetic mean of its normalized ESG indicators for the period 2022–2024. The aggregate ESG model’s inputs are summarized below by normalized values of all indicators, where we standardize multiple-dimensional environmental indicators on a common scale by doing so.

**TABLE 18 |** Normalized esg indicator scores for Turkish banks (2022–2024 Averages)

Bank	CCS	WSC	WC	GHGE	NP/WC	NP/TE	L/WC	L/TE	D/WC	D/TE
AKBNK	0,48	0,50	0,36	0,71	0,96	0,70	0,90	0,37	0,13	0,18
ALBRK	0,00	0,00	1,00	1,00	0,07	0,02	0,00	0,00	0,00	0,00
GARAN	0,92	1,00	0,06	0,74	1,00	1,00	0,75	0,44	1,00	1,00
HALKB	0,92	1,00	0,09	0,00	0,00	0,00	1,00	0,13	0,76	0,28
VAKBN	0,74	0,70	0,00	0,93	0,22	0,59	0,97	1,00	0,14	0,49
YKBNK	1,00	0,90	0,23	0,09	0,72	0,23	0,61	0,06	0,06	0,02

**Note:** The indicator values of all indicators are normalized on a 0–1 scale to enable proper comparison of multiple ESG dimensions across different indicators. Abbreviations used are CCS (Climate Change Score), WSC (Water Security Score), WC (Water Consumption), GHGE (Greenhouse Emissions), NP/WC (Net Profit per Water Consumption), NP/TE (Net Profit per Total Emissions), L/WC (Loans per Water Consumption), L/TE (Loans per Total Emissions), D/WC (Deposits per Water Consumption), and D/TE (Deposits per Total Emissions). It shows higher values for stronger sustainability-adjusted performance

Table 18 presents the normalized scores for each ESG indicator across six Turkish banks based on their three-year averages (2022–2024). These scores, scaled between 0 and 1, enable objective comparisons by standardizing different metrics. YKBNK achieves the highest score in climate-related disclosures, while ALBRK demonstrates top performance in resource efficiency. Conversely, VAKBN displays relatively lower scores in emission-adjusted metrics. These values serve as the input for the composite ESG scoring process discussed in the next section.

**TABLE 19 |** Composite esg scores and rankings (2022–2024 Average)

Rank	Bank	Composite ESG Score
1	GARAN	0,791
2	VAKBN	0,579
3	AKBNK	0,527
4	HALKB	0,418
5	YKBNK	0,391
6	ALBRK	0,208

**Note:** Composite ESG scores are calculated as the arithmetic mean of ten normalized ESG indicators for each bank, covering the 2022–2024 period. Scores range from 0 (lowest sustainability performance) to 1 (highest), enabling standardized cross-bank comparisons

Composite ratings of ESG that appear above were calculated through the arithmetic mean of a list of normalized indicators of ESG per bank, utilizing the formula presented under Section 3.6. It assigns equal importance to each dimension and allows institutions to equitably compare their overall ESG performance on a factual basis. Those measures result in values between 0 and 1, where a larger value shows a higher integration of sustainability and efficiency of operation.

### 4.4. Interpretation of composite ESG scores and sectoral insights

Composite ESG ratings, derived from a normalized pool of environmental indicators, give a rounded picture of Turkish banking institutions’ sustainability performance for the period of 2022–2024. Results indicate a wide range of incorporation and operating efficiency across institutions. GARAN achieves the highest value (0.791), indicating a balanced fulfillment of both environmental efficiency and environment-adjusted financial indicators. GARAN has also been found to achieve significantly high ratings across emission-adjusted profitability and loan metrics, indicating that it managed to maintain financial productivity while maintaining an environmental footprint to a minimum. That is consistent across research studies on sustainable banking where financial institutions capable of including carbon performance into a financial activity are found to generate a better value for a longer term perspective and keep ecological footprints minimum (Jeucken, 2001; Weber, 2014).

VAKBN, the second-highest-ranked bank (0.579), also exhibited strong environmental productivity, mainly in emission-adjusted measures of deposits and loans. The type of quality observed here aligns with empirical research, which explains positive associations between leading ESG scoring of green credit and carbon monetized indicators to better risk management and long-term institutional strength (Busch, 2010; Cui et al., 2018). However, comparatively poor shows by climate-related disclosure (CCS) and water security score (WSC) moderated its overall position to a limited degree. On a negative, YKBNK, having best-normalized indicators in CCS and WSC indicators, placed fifth overall at 0.391, mainly due to below-par performances on efficiency-based indicators of Loans per Water Consumption and Net Profit per Carbon. The difference highlights a balance to strike between strategic communication and operational sustainability results. Prior research emphasizes that firms often score high in disclosure-oriented ESG metrics while underperforming in operational efficiency, highlighting the distinction between symbolic and substantive sustainability practices (Boiral, 2013; Cho et al., 2015).

At the lower end, ALBRK (0.208) and HALKB (0.418) have minimal ESG alignment, specifically in emission-adjusted and profit-adjusted criteria. The finding corroborates evidence that institutions with poor ESG integration are prone to find it hard to link environmental performance with core financial metrics, where sustainability practices are not integrated into risk and profitability frameworks (Dienes et al., 2016; Weber, 2014). ALBRK’s extremely poor rankings for emission efficiency and notable performance indicators suggest potential for structural reforms. HALKB, whereas relatively better for disclosure, exhibited discrepancies in environmental impact management, mainly in total GHG emissions and water efficiency.

These outcomes unpack Turkish banks’ ESG heterogeneity. Whereas institutions are ahead of other institutions in matching environmental footprint and profitability, there are institutions that are imbalanced, disjointed, or mismatched in their ESG programs. The outcomes reflect how paired operant efficiency and disclosure strategy are the roots of stretched superior ESG performance. Both of these are validated through literature, which reveals that sustainability leadership is not merely dependent on clear disclosing reporting but also on the ability to internalize ESG principles into day-by-day routine and money-making decisions (Eccles et al., 2014; Michelon et al., 2015). The difference also highlights requirements for standard, clear ESG reporting frameworks as well as additional regulatory incentives for compelling sectoral ESG integration sustainability.

## 5. Conclusion

This study addressed a critical gap in the ESG literature by developing a comprehensive, standardized methodology to evaluate the environmental sustainability performance of Turkish banks between 2022 and 2024. The central research questions were:

(1) How do the selected Turkish banks compare in terms of their environmental performance across key ESG indicators?

(2) Can a composite ESG score, derived from normalized metrics, offer a reliable and comparative assessment across institutions?

The findings indicate significant variability in performance across banks. GARAN ranks highest overall, reflecting consistent environmental efficiency, low emissions per output, and strong sustainability-adjusted profitability. These outcomes align with prior findings that associate superior ESG performance with firms that embed sustainability into their financial processes and emissions governance (Jeucken, 2001; Weber, 2014). Conversely, ALBRK ranks lowest due to high resource intensity and lower emissions-adjusted returns, despite relatively good disclosure scores. This divergence aligns with the literature that distinguishes between symbolic disclosure and substantive sustainability performance, particularly in institutions that lack operational integration of environmental metrics (Boiral, 2013; Cho et al., 2015). These results validate the effectiveness of combining direct and inverse normalization techniques to integrate diverse ESG indicators into a coherent scoring framework.

Some unexpected insights also emerged. While YKBNK performed well in disclosure and emission-related indicators, its composite ESG score ranked just below average. This reveals a disconnect between policy-level commitments and operational efficiency. Similar patterns appear in studies showing that formal ESG commitments do not always yield concrete outcomes, especially in high-disclosure sectors like finance (Eccles et al., 2014; Michelon et al., 2015). HALKB, despite high climate disclosure ratings, scored poorly on efficiency indicators, highlighting the need to evaluate both intent and impact in ESG assessments. This supports the ESG literature, which distinguishes between disclosure-driven signaling and actual performance, where firms may demonstrate transparency without achieving real sustainability outcomes (Adams, 2004; Cho et al., 2015).

The novelty of this study lies in its dual contribution: methodologically, by introducing a structured normalization approach suitable for ESG synthesis in the banking sector; and empirically, by providing the first longitudinal ESG composite scoring for Turkish banks. These results add to ESG literature by focusing on sector-specific operational efficiency rather than general sustainability indices. This aligns with critiques that emphasize the need for ESG evaluations to include industry-specific metrics, thereby enhancing relevance and comparability, particularly in sectors where operational impacts vary (Dienes et al., 2016; Siew et al., 2016). Compared to studies relying on external ESG ratings or annual assessments, our approach minimizes temporal noise by averaging over three years and correcting for indicator heterogeneity. Discrepancies, particularly in disclosure-leading banks underperforming in efficiency metrics, highlight the need for more nuanced ESG evaluation. This echoes critiques that high disclosure scores may reflect symbolic adoption of sustainability rhetoric rather than operational performance (Boiral, 2013; Michelon et al., 2015).

Based on this methodological groundwork, further studies might also explore how composite ESG scores are communicated efficiently through banks' internal decision-making processes. Such scores might inform a variety of strategy processes, for instance, credit granting, risk committee discussions, and asset-liability management procedures. It is possible to incorporate ESG performance into these financial management mechanisms, thereby bringing sustainability goals into conformity with major focus areas like capital allocation, risk tolerance, and long-term strategy. Such potential for applicability also underscores ESG metrics' importance, changing their purpose from simple disclosure utilities to choice-making utilities, enriching accountability and transparency.

The results of this research have explicit regulatory design, institutional governance, and sectoral sustainability planning implications. Firstly, the Banking Regulation and Supervision Agency (BDDK) might

incorporate standardized ESG scoring processes into supervisory reporting to allow for data consistency and comparability across institutions. Secondly, the Banks Association of Turkey (TBB) might create a centralized ESG data repository, which collates environmental performance indicators, and allows for sector-wide benchmarking and stakeholder access to verified sustainability information. Thirdly, policymakers might encourage banks to include composite ESG ratings in credit allocation and capital adequacy models, tying environmental performance to risk-weighting systems and green finance eligibility criteria. Fourthly, the Central Bank of the Republic of Turkey (CBRT) might incorporate ESG factors into macroprudential and monetary policy designs, promoting sustainable lending and investment behavior institution-wide. Fifthly, mandatory external assurance of ESG reports, consistent with the ISSB and ESRS disclosure standards, would enhance accountability, minimize symbolic compliance, and encourage substantive integration of sustainability. Cumulatively, these steps would expedite Turkish banking's adherence to global sustainability governance, derailing ESG from a reporting requirement to a central aspect of financial regulation and strategic management.

In light of these insights, the results reinforce the need to move beyond voluntary reporting and toward more structured performance benchmarking. This perspective is consistent with previous research suggesting that relying solely on ESG disclosures, particularly those lacking standardization, limits the ability of stakeholders to assess true sustainability performance. As Douglas et al. (2017) point out, standardized metrics are essential for enabling meaningful comparisons across institutions. Similarly, Ioannou and Serafeim (2019) argue that the value of mandatory reporting depends on the presence of verification mechanisms that ensure accountability. Policymakers could benefit from adopting ESG scoring models that integrate normalization techniques, while investors, regulators, and customers may use these tools to inform their decisions more effectively. The approach developed in this study provides a foundation for such efforts, offering a practical and adaptable framework for monitoring ESG performance within the banking sector.

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