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Comparative Assessment of Climate Change Performance: Türkiye vs. G7 Countries Using a Hybrid MPSI-MABAC Approach

İklim Değişikliği Performansının Karşılaştırmalı Analizi: Türkiye ve G7 Ülkelerinin Hibrit MPSI-MABAC Yaklaşımı ile Değerlendirilmesi

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Abstract

Climate change has become one of the most pressing global challenges, with its impacts intensifying in recent years. For Türkiye, addressing climate change is critical due to its growing economy, rising emissions, and vulnerability to environmental risks. This study underscores the importance of comparing Türkiye's climate change performance with G7 countries using Environmental Performance Index (EPI) data to identify gaps and opportunities for improvement. The aim of this study is to compare Türkiye's climate change performance with that of G7 countries by utilizing Environmental Performance Index (EPI) data and applying a hybrid MPSI-MABAC methodology. A hybrid Multi-Perspective Strategic Integration (MPSI) and Multi-Attributive Border Approximation Area Comparison (MABAC) methodology was applied to rank the countries based on climate-related criteria. Among these, "Projected cumulative emissions to 2025 relative to carbon budget" (C10) was identified as the most significant factor. The findings reveal that the United Kingdom, Germany, and France lead in performance, while Türkiye and Canada are the lowest-ranked. This analysis provides valuable insights to governments, businesses and researchers for shaping national policies and fostering international cooperation to combat climate change effectively.

Keywords: Environmental Performance Index (EPI), Climate Change, Türkiye, MPSI, MABAC.

Öz

İklim değişikliği, etkilerinin son yıllarda daha da şiddetlenmesiyle birlikte, en acil küresel zorluklardan biri haline gelmiştir. Türkiye için iklim değişikliği ile mücadele, büyüyen ekonomisi, artan emisyonları ve çevresel risklere karşı kırılganlığı nedeniyle büyük önem taşımaktadır. Bu çalışma, Türkiye'nin iklim değişikliği performansını G7 ülkeleriyle karşılaştırmanın önemini vurgulamakta ve bu karşılaştırmayı, iyileştirilmesi gereken alanları ve fırsatları belirlemek amacıyla Çevresel Performans Endeksi (EPI) verilerini kullanarak gerçekleştirmektedir. Çalışmanın amacı, Türkiye'nin iklim değişikliği performansını G7 ülkeleriyle karşılaştırmak, en kritik kriter olan "2025'e kadar karbon bütçesine göre projeksiyonlu kümülatif emisyonlar" (C10) odak noktasında güçlü ve zayıf yönlerini belirlemektir. Ülkeler, Çok Yönlü Stratejik Entegrasyon (MPSI) ve Çok Nitelikli Sınır Yaklaşım Alanı Kıyaslaması (MABAC) hibrit metodolojisi kullanılarak iklimle ilgili kriterler temelinde sıralanmıştır. Bulgular, Birleşik Krallık, Almanya ve Fransa'nın performansta önde olduğunu, Türkiye ve Kanada'nın ise en düşük sıralarda yer aldığını ortaya koymaktadır. Bu analiz, hükümetler, işletmeler ve araştırmacılar için ulusal politikaların şekillendirilmesi ve iklim değişikliğiyle etkili bir şekilde mücadele edilmesi amacıyla uluslararası iş birliğini teşvik edecek değerli bilgiler sunmaktadır.

Anahtar Kelimeler: Çevresel Performans Indeksi (ÇPI), İklim Değişikliği, Türkiye, MPSI, MABAC.

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Comparative Assessment of Climate Change Performance: Türkiye vs. G7 Countries Using a Hybrid MPSI-MABAC Approach

The changing climate has been one of the major global issues of the past few decades; indeed, its effects are worsened day by day and widens its circle (Khanna et al., 2022). The rising temperature globally, intensified extremes of weather patterns, loss of biodiversity, and disturbance in ecosystems have already called for an instant unified international response (Abbass et al., 2022). Climate change is no longer an issue of the future; rather, it is well evident in most parts of the globe and is increasingly affecting human health, food security, and economic stability. These newly emerging risks have placed management of climate change at the forefront among governments, institutions, and individuals (Newell et al., 2021).

This study used the MPSI-MABAC hybrid method to determine position and ranking of Türkiye among the G7 countries. The G7 countries are exceptional in terms of environmental performance since they have high-level technologies, powerful economic capabilities, and comprehensive environmental policies (Zhao et al., 2023). Besides, these countries are ranked in frontier positions with regard to developing and implementing new approaches for the achievement of sustainable development. Their set standards, therefore, regarding renewable energy, emission reduction, and nature conservation become the benchmark for other countries (Wang et al., 2024). The G7's environmental performance is central, therefore, to global efforts toward combating climate change and promoting environmental sustainability (Fatima et al., 2024). A comparison of Türkiye with the G7 nations within the framework of the Environmental Performance Index (EPI) will, therefore, be important in assessing the efforts of Türkiye to reach environmental sustainability and catch up with global standards (Karahan et al., 2025). G7 nations are normally characterized by developed economies, very strict environmental policies, and highly developed infrastructures. Comparisons like these will therefore provide indications of the weaknesses and strengths of environmental performance that will be of real value to policymakers and strategic planners (Wang et al., 2024). Comparisons will also play a key role in the international collaboration on climate change and optimize the contribution of Türkiye to global environmental goals.

For Türkiye, combating climate change is of particular importance (Xu et al., 2022) Having a rapidly growing economy, rapid urbanization, and rising greenhouse gas emissions, the country reaches a fork in the road (Taneja and Özen, 2023). Furthermore, Türkiye's landscape renders it vulnerable to all kinds of negative environmental risks like droughts, floods, and heatwaves that may have potential huge implications for its economy and society (Arslan, 2023). These issues need to be addressed by inclusive policies and strategies capable of reconciling economic growth with environmental sustainability (Çakmakçı et al., 2023). It recognizes urgency, and over the couple of last years, Türkiye has taken important steps: investments in renewable energy, energy efficiency projects, and ratification of the Paris Climate Agreement-all signals of a deepening commitment to integrating climate action into national development agendas (Deniz et al., 2024).

The EPI has become one of the most important metrics by which countries compare their responses to climate change and the environment (Usubiaga-Liaño and Ekins, 2021). EPI utilizes data-driven scrutiny in facilitating an impartial analysis of country rankings on varied measures of sustainability, including but not limited to emission curtailment, renewable energy, and implementations of environmental policy In this study, data from the Climate Change section of the EPI 2024 Report were used (EPI, 2024). Benchmarking of Türkiye with G7 countries (advanced economies with comprehensive climate policy) therefore has the value added of highlighting areas where it remains behind and is able to learn something from global best practice. Comparative assessment identifies areas of environmental performance that show scope for approximation to global standards (Karahan et al., 2025). This study focuses on G7 countries due to their leading role in global environmental governance, advanced technologies, and strong policy frameworks. While acknowledging the importance of emerging economies within the G20, the scope here is limited to Western OECD countries to benchmark Türkiye against the most developed economies with established environmental policies.

It is fairly important in this case to apply the MCDM methodology since it frames multi-dimensional problems-in this case, climate change problems-within a decision-making framework (Zevdu et al., 2024). MCDM methods may allow the consideration of a lot of criteria at a time, and hence provide a system to rank options and determine the most important factors on performance (Ghaleb, 2020). The article has adopted a hybrid approach, combining Multi-Perspective Strategic Integration with Multi-Attributive Border Approximation Area Comparison, which gives an overall analytic model for measuring performance in climate change for Türkiye with respect to G7 countries on key indicators.

Literature Review

During the past years, several MCDM methods have been applied to climate change performance-based problems, sustainability, energy, and environmental issues (Alsanousi et al., 2024; Karahan et al., 2025; Bajdor and Korpysa, 2025). These works collect extensive data from, for instance, the Environmental Performance Index, Climate Change Performance Index, and the Global Green Growth Institute, which can provide access to quite informative data reflecting the intricacy of climate change and sustainability. In their study Ayçin and Çakın (2019) used Entropy, Gray Relational Analysis (GRA) and Multi Objective Optimization on the basis of Ratio Analysis (MOORA) methods to measure the environmental performance of the countries with using data from EPI. The aim of Mohaghar et. al. (2019)'s study is to prioritize the OECD Countries based on their EPI Indicators. They used Shannon ENTROPHY and TOPSIS hybrid method. Altıntaş (2021a) used ROV and MAUT to assess the climate change protection performance of G20 countries based on data derived from CCPI. In his study Altıntaş (2021b) aimed to calculate the significance levels of the EPI components of the countries in question by using the ENTROPY method based on the data of the components that make up the EPI of 19 countries in the G20 group for 2020 and to measure the environmental performance of countries with the ENTROPY-based ROV, ARAS and COPRAS methods. With using CRITIC and CoCoSo hybrid method Acar (2022) aimed to compare the performances of OECD countries between 2015 and 2019 within the context of socio-economic global indices. Gökgöz and Yalcin (2022) researched environmental and energy sustainability with CRITIC, VIKOR, and CoCoSo methodologies using OECD data for the period from 2012 to 2018. The authors show the merits of the methods they have applied for the assessment of environmental sustainability within the context of developed economies. Kısa (2022) used ENTROPY-WASPAS hybrid method with the aim of evaluating the environmental performances of OECD countries with using the data taken form EPI. Eşiyok et al. (2023), Entropy, CRITIC, EDAS, LOPCOW MCDM methods to be used for finding the environmental performance ranking of G7 countries and Türkiye from data taken in the Global Green Growth Index. They figured out that indicator of efficient use of sustainable resource is a strong determinant on country's environmental performance. Senir (2024) utilized ENTROPY, COPRAS, and WASPAS approaches for assessing the dimensions of sustainability in environmental matters using data taken from the Environmental Performance Index. In the paper of Puska et al. (2024) was assessed the effectiveness of the implementation of climate change management strategies across European Union (EU) member states, based on data from the CCPI using the MABAC MCDM method. Köse et al. (2024) aimed at investigating activities about climate change before and during the COVID-19 pandemic based on G-20 countries. They used the PROMETHEE and MEREC hybrid MCDM method in this study. Karahan et al. (2025) aimed to find out Türkiye's environmental performance was evaluated using the Entropy-based PROMETHEE method with using international EPI 2022 data. Bajdor and Korpysa (2025) environmental performance of the countries using data taken from EPI with using TOPSIS method. The relevant literature about the Sustainability of Countries is presented in Table 1.

Table 1

Related literature for Climate Change Performance of Countries analysis using MCDM

Authors	Methods	Sector	Years	Index
Ayçin and Çakın 2019	ENTROPY, GRA, MOORA	Environmental Performance	2018	EPI
Mohaghar et al., 2019	SHANNON ENTROPY, TOPSIS	Environmental Performance	2016	EPI
Altıntaş, 2021a	ROV, MAUT	Climate Change Protection Performance	2021	CCPI
Altıntaş, 2021b	ENTROPY, ROV, ARAS, COPRAS	Environmental Performance		EPI
Acar, 2022	CRITIC, CoCoSo	Socio Economic Performance		OECD
Gökgöz and Yalcin, 2022	CRITIC, VIKOR, CoCoSo	Environmental and Energy Sustainability	2012-2018	OECD
Kısa, 2022	ENTROPY, WASPAS	Environmental Performance	2020	EPI
Eşiyok et al., 2023	ENTROPY, CRITIC EDAS	Environmental Performance Rankings	2010-2020	GGGI
Senir, 2024	ENTROPY, COPRAS, WASPAS	Environmental Sustainability	2022	EPI
Puska et al., 2024	MABAC	Climate Change Management	2024	CCPI
Köse et al., 2024	MEREC	Climate Change Performances	2024	CCPI
Karahan et al., 2025	Entropy-based PROMETHEE	Environmental Performance	2022	EPI
Bajdor and Korpysa, 2025	TOPSIS	Environmental Performance	2022	EPI

Methodology

In this study, MPSI-MABAC novel hybrid method has been developed and proposed for finding the situation and ranking the Türkiye among G7 countries in terms of climate change performances. The methodological flow of the research is conducted in two stages. In Stage 1, the weights of the criteria are calculated using the MPSI method. Stage 2, the final utility function values of the countries are calculated using the MABAC method and country rankings are obtained.

MPSI-MABAC Hybrid Model

The two stage MPSI-MABAC hybrid model has been proposed to rank the environmental performance of countries. Let $(\mathcal{A}_{ţ}) = \{\mathcal{A}_1, \mathcal{A}_2, \dots, \mathcal{A}_{Ţ}\}$ $(ţ = 1,2,\dots,Ţ)$ represent alternatives and $(\mathcal{C}_{ư}) = \{\mathcal{C}_1, \mathcal{C}_2, \dots, \mathcal{C}_{Ư}\}$ $(ư = 1,2,\dots,Ư)$ represent criteria. The steps of the proposed MPSI-MABAC hybrid model are outlined as follows:

Stage 1: Calculating the weighting of criteria with MPSI method (Gligorić et. al., 2022)

Step 1: A decision matrix $\left(D = \left[D_{ţư}\right]_{ŢƯ}\right)$ consisting of Ư criteria and Ţ alternatives is formed is obtained. This decision matrix is constructed as shown in Eq. (1).

$$D = \left[D_{ţɯ}\right] = \begin{bmatrix} D_{11} & \cdots & D_{1ɯ} & \cdots & D_{1Ʊ} \\ \vdots & \cdots & \vdots & \cdots & \vdots \\ D_{ţ1} & \cdots & D_{ţɯ} & \cdots & D_{ţƱ} \\ \vdots & \cdots & \vdots & \cdots & \vdots \\ D_{ţ1} & \cdots & D_{ţɯ} & \cdots & D_{ƮƱ} \end{bmatrix}; (ţ = 1,2,\ldots, Ʈ; ɯ = 1,2,\ldots, Ʊ). \quad (1)$$

Step 2: The decision matrix is normalized using Eq. (2) and (3) respectively. Hence, the normalized decision matrix $\left(\mathbb{N} = \left[\mathbb{N}_{ţɯ}\right]_{ƮƱ}\right)$ is obtained.

$$\mathbb{N}_{ţɯ} = \frac{D_{ţɯ}}{\max_{ţ=1,2,\ldots,Ʈ} D_{ţɯ}}, \ for\ beneficial\ criteria \quad (2)$$

$$\mathbb{N}_{ţɯ} = \frac{\min_{ţ=1,2,\ldots,Ʈ} D_{ţɯ}}{D_{ţɯ}}, for\ non-beneficial\ criteria \quad (3)$$

Step 3: The mean value matrix ($\mathfrak{M} = [\mathfrak{M}_{ɯ}]_{Ʊ}$) is obtained by using Eq. (4).

$$\mathfrak{M}_{Ʊ} = \frac{1}{Ʈ}\sum_{ţ=1}^{Ʈ} \mathbb{N}_{ţɯ} \quad (4)$$

Step 4: the preference variation matrix ($\Psi = [\Psi_{ɯ}]_{Ʊ}$) is obtained by using Eq. (5).

$$\Psi_{Ʊ} = \sum_{ţ=1}^{Ʈ}\left(\mathbb{N}_{ţɯ} - \mathfrak{M}_{Ʊ}\right)^2 \quad (5)$$

Step 5: The criteria weight matrix ($\omega = [\omega_{ɯ}]_{Ʊ}$) is obtained by using Eq. (6).

$$\omega_{ɯ} = \frac{\Psi_{Ʊ}}{\sum_{ɯ=1}^{Ʊ} \Psi_{Ʊ}} \quad (6)$$

<u>*Stage 2: Ranking the alternatives with MABAC method*</u> (Pamučar and Ćirović, 2015)

Step 6: Firstly, the decision matrix in Step 1 is created. Then, the normalized decision matrix $\left(\mathrm{Ɲ} = \left[\mathrm{Ɲ}_{ţɯ}\right]_{ƮƱ}\right)$ elements are obtained by Eq. (7).

$$\mathrm{Ɲ}_{ţɯ} = \begin{cases} \dfrac{D_{ţɯ} - \min_{ţ=1,2,\ldots,Ʈ}(D_{ţɯ})}{\max_{ţ=1,2,\ldots,Ʈ}(D_{ţɯ}) - \min_{ţ=1,2,\ldots,Ʈ}(D_{ţɯ})}; for\ beneficial\ criteria \\ \dfrac{D_{ţɯ} - \max_{ţ=1,2,\ldots,Ʈ}(D_{ţɯ})}{\min_{ţ=1,2,\ldots,Ʈ}(D_{ţɯ}) - \max_{ţ=1,2,\ldots,Ʈ}(D_{ţɯ})}; for\ non-beneficial\ criteria \end{cases} \quad (7)$$

Step 7: The weighted decision matrix $\left(\text{Щ} = \left[\text{Щ}_{ţɯ}\right]_{ƮƱ}\right)$ is obtained by using Eq. (8).

$$\text{Щ}_{ţɯ} = \omega_{ɯ}\left(\mathrm{Ɲ}_{ţɯ} + 1\right) \quad (8)$$

Step 8: The boundary proximity area (BPA) matrix $\left(\mathfrak{P} = \left[\mathfrak{P}_{ţ}\right]_{Ʈ}\right)$ is obtained by using Eq. (9).

$$\mathfrak{P}_{ţ} = \left(\prod_{ɯ=1}^{Ʊ} \text{Щ}_{ţɯ}\right)^{1/Ʊ} \quad (9)$$

Step 9: The distance matrix of alternatives $\left(\mathfrak{D} = \left[\mathfrak{D}_{ţɯ}\right]_{ƮƱ}\right)$ to the BPA is obtained by using Eq. (10).

$$\mathfrak{D}_{ţɯ} = \text{Щ}_{ţɯ} - \mathfrak{P}_{ţ} \quad (10)$$

Step 10: The final distance matrix $\left(\Upsilon = [\Upsilon_{ţ}]_{Ţ}\right)$ is obtained by using Eq. (11). The most suitable option is determined as the alternative with the highest value.

$$\Upsilon_{ţ} = \sum_{ư=1}^{Ư} \mathfrak{D}_{ţư} \tag{11}$$

The algorithm of the MPSI-MABAC hybrid model is presented in Table 2.

Table 2

Algorithm-1

Algorithm	*The goal of this algorithm is to evaluate the performance of alternatives using MPSI-MABAC model.*
Input	As a set of alternatives $(\mathcal{A}_{ţ}) = \{\mathcal{A}_1, \mathcal{A}_2, \dots, \mathcal{A}_{Ţ}\}$ $(ţ = 1,2,\dots,Ţ)$ and criteria $(\mathcal{C}_{ư}) = \{\mathcal{C}_1, \mathcal{C}_2, \dots, \mathcal{C}_{Ư}\}$ $(ư = 1,2,\dots,Ư)$ for calculating weighting of criteria matrix $(\omega = [\omega_{ư}]_{Ư})$ and ranking of alternatives matrix $\left(\Upsilon = [\Upsilon_{ţ}]_{Ţ}\right)$.
Output	Assessing the performance of alternatives.
Step 1	Obtain the decision matrix $\left(D = [D_{ţư}]_{ŢƯ}\right)$ (Eq. (1)).
Step 2	Obtain the normalized decision matrix $\left(\mathbb{N} = [\mathbb{N}_{ţư}]_{ŢƯ}\right)$ using Eq. (2) and Eq. (3).
Step 3	Obtain the mean value matrix $(\mathfrak{M} = [\mathfrak{M}_{ư}]_{Ư})$ using Eq. (4).
Step 4	Obtain the preference variation matrix $(\Psi = [\Psi_{ư}]_{Ư})$ using Eq. (5).
Step 5	Obtain the criteria weighting matrix $(\omega = [\omega_{ư}]_{Ư})$ using Eq. (6).
Step 6	Obtain the normalized decision matrix $\left(\text{Ɲ} = [\text{Ɲ}_{ţư}]_{ŢƯ}\right)$ using Eq. (7).
Step 7	Obtain the weighted decision matrix $\left(\text{Щ} = [\text{Щ}_{ţư}]_{ŢƯ}\right)$ using Eq. (8).
Step 8	Obtain the BPA matrix $\left(\mathfrak{P} = [\mathfrak{P}_{ţ}]_{Ţ}\right)$ using Eq. (9).
Step 9	Obtain the distance matrix $\left(\mathfrak{D} = [\mathfrak{D}_{ţư}]_{ŢƯ}\right)$ using Eq. (10).
Step 10	Obtain final distance matrix $\left(\Upsilon = [\Upsilon_{ţ}]_{Ţ}\right)$ using Eq. (11). The highest value of $\Upsilon_{ţ}$ is the best option.
End.	

Application

Climate change is the biggest global challenge of our time, and it affects all natural systems, human economies, and societies at unprecedented scales (Abbass et al., 2022). Its importance has grown due to its wide range of impacts, from extreme weather to rise in sea level, loss of biodiversity, to food and water security (Muluneh, 2021). All these implications give a signal about the urgency of mitigating climate change and adapting to its consequences (Kemp et al., 2022). Being under constant drought and flood threats or other climatic dangers, addressing climate change is of prime significance for Türkiye (Giovanis and Ozdamar, 2024). At the same time, as a developing nation with the necessity of economic growth, there is also a double responsibility for Türkiye in reducing GHG emissions and attaining sutainable development (Adebayo et al., 2022). EPI is central to comparative analysis and assessment of nations' environmental policy and performance. The EPI was designed by Yale University and typically provides a composite methodology in ranking countries based on various indicators: air quality, biodiversity, climate policy, and resource efficiency. For example, the EPI provides useful information on climate change in terms of tracking countries' adherence to global climate goals. Such information will, therefore, be quite relevant to identify gaps and chances for climate action (EPI, 2024). For Türkiye, it is quite pertinent to be evaluated by the EPI and compared with the G7 countries. Such a comparison can provide a general view of the position of Türkiye in the world and which one is in the best place regarding climate policy (Karahan et al., 2025). The substantial disparity highlights the need for Türkiye to strengthen its environmental policy framework and set more ambitious targets for transitioning to a low-carbon economy. Furthermore, basing such a comparison on EPI data allows Türkiye to benchmark itself against other developed economies, which is necessary for developing better policies on climate change (Ağbulut et al., 2023). These efforts are not only significant in terms of the environmental sustainability of Türkiye but also vital for gaining a better reputation in the global fight against climate change.

Criteria and Alternatives

Criteria are taken from EPI 2024 Report's Climate Change's 11 main criteria which are "Adjusted emissions growth rate for carbon dioxide (C1)", "Adjusted emissions growth rate for carbon dioxide (country-specific targets) (C2)", "Adjusted emissions growth rate for methane (C3)", "Adjusted emissions growth rate for F-gases (C4)", "Adjusted emissions growth rate for nitrous oxide (C5)", "Adjusted emissions growth rate for black carbon (C6)", "Net carbon fluxes due to land cover change (C7)", "GHG growth rate adjusted by emissions intensity (C8)", "GHG growth rate adjusted by per capita emissions (C9)"," Projected emissions in 2050 (C10)" and "Projected cumulative emissions to 2050 relative to carbon budget (C11)". (EPI, 2024)

Adjusted emissions growth rate for carbon dioxide (C1): This is the measure of a country's CO2 emissions over time as an indicator of whether or not that nation's policies and activities actually reduce this critical greenhouse gas, allowing for economic growth or other national circumstances that might affect the emissions trend.

Adjusted emissions growth rate for carbon dioxide (country-specific targets) (C2): Like the previous criterion, this criterion considers the growth in CO2 reduction commitment. That means accountability regarding country level targets set within international climate commitments.

Adjusted emissions growth rate for methane (C3): Methane, being a potent GHG, is accounted for under this criterion to identify its emission trend. This allows the adjustments to consider the ways of agriculture, the mode of energy production, and mitigations made accordingly.

Adjusted emissions growth rate for F-gases (C4): This criterion considers the fluorinated gas growth rate; thus, they are synthetic, very powerful gases. It takes into account industrial policy cuts and F-gases substitution.

Adjusted emissions growth rate for nitrous oxide (C5): Nitrous oxide, mainly from agriculture, is taken into consideration in this indicator because of its growth rate, whereas in the adjustment, efforts are considered at the level of control of fertilizers and industrial emissions.

Adjusted emissions growth rate for black carbon (C6): This is an Emissions Trend Indicator of black carbon, one of the Short-Lived Climate Pollutants (SLCPs). It gives an indication of the level of effort at limiting sources of the gas, such as diesel engines and biomass burning.

Net carbon fluxes due to land cover change (C7): The indicator is to account for balance between carbon emissions and uptake owing to land-use change-for example, deforestation or reforestation-and the contribution that land management makes toward carbon sequestration

GHG growth rate adjusted by emissions intensity (C8): It is an increase in GHG emissions about the economic output of a nation and reflects progress in decoupling the growth of the economy from the growth of emissions. It reflects progress in the use of energy efficiency and cleaner technology.to improve energy efficiency and adopt cleaner technologies.

GHG growth rate adjusted by per capita emissions (C9): This criterion normalizes the GHG emission trend by population size for equitably comparing the growth in GHG emission for nations with a varying population base.

Projected emissions in 2050 (C10): It forecasts the greenhouse gas emissions of a country in 2050, showing a long-term perspective perhaps for the climatic effect of the emissions. This suggests the need for haste in embracing viable mitigation strategies.

Projected cumulative emissions to 2050 relative to carbon budget (C11): It compares and contrasts a country's cumulative emissions by 2050 with the available global remaining carbon budget to limit warming to specific targets. This indicates the need for maintaining emissions within sustainable thresholds.

Alternatives are Türkiye (A1), United States (A2), United Kingdom (A3), Canada (A4), France (A5), Germany (A6), Italy (A7), Japan (A8).

Calculating the Weighting of Criteria Using MPSI Method

Calculating the weighting of criteria with MPSI method

Step 1: A decision matrix consisting of 8 alternatives and 11 criteria is formed as in Eq. (1). The decision matrix is shown in Table 3.

Table 3

The Decision Matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
A_1	40.90	25.00	28.00	30.20	16.90	100.00	51.90	36.60	30.80	0.70	44.20
A_2	57.70	33.30	50.50	46.70	55.20	100.00	50.20	52.50	35.50	0.00	50.10
A_3	74.30	77.30	58.60	56.80	52.50	86.50	47.00	67.10	61.60	100.00	91.60
A_4	52.50	27.10	65.70	41.40	44.30	100.00	49.80	48.30	33.10	4.10	45.20
A_5	60.90	59.10	69.10	73.30	70.10	100.00	51.10	59.10	53.60	12.80	77.70
A_6	68.30	56.90	87.00	55.70	85.70	97.80	52.10	62.60	53.40	14.90	78.40
A_7	55.90	45.40	51.90	40.50	56.70	100.00	52.90	54.60	48.00	9.20	67.60
A_8	63.10	48.40	72.30	40.60	63.30	100.00	50.50	61.10	52.80	10.00	76.90

Step 2: Since all criteria are benefit criteria, the normalized decision matrix is obtained by using only Eq. (2). The normalized decision matrix is shown in Table 4.

Table 4

Normalized Decision Matrix

	$\mathcal{C}_1$	$\mathcal{C}_2$	$\mathcal{C}_3$	$\mathcal{C}_4$	$\mathcal{C}_5$	$\mathcal{C}_6$	$\mathcal{C}_7$	$\mathcal{C}_8$	$\mathcal{C}_9$	$\mathcal{C}_{10}$	$\mathcal{C}_{11}$
$\mathcal{A}_1$	0.5505	0.3234	0.3218	0.4120	0.1972	1.0000	0.9811	0.5455	0.5000	0.0070	0.4825
$\mathcal{A}_2$	0.7766	0.4308	0.5805	0.6371	0.6441	1.0000	0.9490	0.7824	0.5763	0.0000	0.5469
$\mathcal{A}_3$	1.0000	1.0000	0.6736	0.7749	0.6126	0.8650	0.8885	1.0000	1.0000	1.0000	1.0000
$\mathcal{A}_4$	0.7066	0.3506	0.7552	0.5648	0.5169	1.0000	0.9414	0.7198	0.5373	0.0410	0.4934
$\mathcal{A}_5$	0.8197	0.7646	0.7943	1.0000	0.8180	1.0000	0.9660	0.8808	0.8701	0.1280	0.8483
$\mathcal{A}_6$	0.9192	0.7361	1.0000	0.7599	1.0000	0.9780	0.9849	0.9329	0.8669	0.1490	0.8559
$\mathcal{A}_7$	0.7524	0.5873	0.5966	0.5525	0.6616	1.0000	1.0000	0.8137	0.7792	0.0920	0.7380
$\mathcal{A}_8$	0.8493	0.6261	0.8310	0.5539	0.7386	1.0000	0.9546	0.9106	0.8571	0.1000	0.8395

Step 3: The mean value matrix is obtained using Eq. (4). Mean value matrix is shown in Table 5.

Table 5

Mean Value Matrix

	$\mathcal{C}_1$	$\mathcal{C}_2$	$\mathcal{C}_3$	$\mathcal{C}_4$	$\mathcal{C}_5$	$\mathcal{C}_6$	$\mathcal{C}_7$	$\mathcal{C}_8$	$\mathcal{C}_9$	$\mathcal{C}_{10}$	$\mathcal{C}_{11}$
$\mathfrak{M}_{\mathfrak{r}}$	0.7968	0.6024	0.6941	0.6569	0.6486	0.9804	0.9582	0.8232	0.7484	0.1896	0.7256

Step 4: The preference variation matrix is obtained using Eq. (5). The preference variation matrix is shown in Table 6.

Table 6

Preference Variation Matrix

	$\mathcal{C}_1$	$\mathcal{C}_2$	$\mathcal{C}_3$	$\mathcal{C}_4$	$\mathcal{C}_5$	$\mathcal{C}_6$	$\mathcal{C}_7$	$\mathcal{C}_8$	$\mathcal{C}_9$	$\mathcal{C}_{10}$	$\mathcal{C}_{11}$
$\Psi_{\mathfrak{r}}$	0.1308	0.3737	0.2875	0.2326	0.3829	0.0156	0.0083	0.1438	0.2408	0.7711	0.2653

Step 5: The importance levels of the criteria were determined by using Eq. (6). The criteria weight matrix is shown in Table 7.

Table 7

Criteria Weight Matrix

	$\mathcal{C}_1$	$\mathcal{C}_2$	$\mathcal{C}_3$	$\mathcal{C}_4$	$\mathcal{C}_5$	$\mathcal{C}_6$	$\mathcal{C}_7$	$\mathcal{C}_8$	$\mathcal{C}_9$	$\mathcal{C}_{10}$	$\mathcal{C}_{11}$
$\omega_{\mathfrak{r}}$	0.0458	0.1310	0.1008	0.0815	0.1342	0.0055	0.0029	0.0504	0.0844	0.2703	0.0930
Ranking	9	3	4	7	2	10	11	8	6	1	5

Ranking the alternatives with MABAC method

Step 6: The decision matrix in Table 3 was also used in the alternative ranking method. Normalization was performed using Eq. (7). The normalized decision matrix is shown in Table 8.

Table 8

Normalized Decision Matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
A_1	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.8305	0.0000	0.0000	0.0070	0.0000
A_2	0.5030	0.1587	0.3814	0.3828	0.5567	1.0000	0.5424	0.5213	0.1526	0.0000	0.1245
A_3	1.0000	1.0000	0.5186	0.6172	0.5174	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000
A_4	0.3473	0.0402	0.6390	0.2599	0.3983	1.0000	0.4746	0.3836	0.0747	0.0410	0.0211
A_5	0.5988	0.6520	0.6966	1.0000	0.7733	1.0000	0.6949	0.7377	0.7403	0.1280	0.7068
A_6	0.8204	0.6099	1.0000	0.5916	1.0000	0.8370	0.8644	0.8525	0.7338	0.1490	0.7215
A_7	0.4491	0.3901	0.4051	0.2390	0.5785	1.0000	1.0000	0.5902	0.5584	0.0920	0.4937
A_8	0.6647	0.4474	0.7508	0.2413	0.6744	1.0000	0.5932	0.8033	0.7143	0.1000	0.6899

Step 7: Weighted decision matrix is obtained by using Eq. (8). The weighted decision matrix is shown in Table 9.

Table 9

Weighted Decision Matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
A_1	0.0458	0.1310	0.1008	0.0815	0.1342	0.0110	0.0053	0.0504	0.0844	0.2722	0.0930
A_2	0.0689	0.1518	0.1392	0.1128	0.2089	0.0110	0.0045	0.0767	0.0973	0.2703	0.1046
A_3	0.0917	0.2620	0.1531	0.1319	0.2037	0.0055	0.0029	0.1008	0.1688	0.5407	0.1860
A_4	0.0618	0.1363	0.1652	0.1027	0.1877	0.0110	0.0043	0.0698	0.0907	0.2814	0.0950
A_5	0.0733	0.2164	0.1710	0.1631	0.2380	0.0110	0.0049	0.0876	0.1469	0.3049	0.1588
A_6	0.0834	0.2109	0.2016	0.1298	0.2684	0.0101	0.0054	0.0934	0.1464	0.3106	0.1601
A_7	0.0664	0.1821	0.1416	0.1010	0.2119	0.0110	0.0058	0.0802	0.1316	0.2952	0.1389
A_8	0.0763	0.1896	0.1765	0.1012	0.2247	0.0110	0.0046	0.0909	0.1447	0.2974	0.1572

Step 8: The BPA matrix was obtained using Eq. (9). The BPA matrix is shown in Table 10.

Table 10

BPA Matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
Ψ_v	0.0697	0.1804	0.1533	0.1132	0.2061	0.0099	0.0046	0.0797	0.1227	0.3134	0.1326

Step 9: The distance matrix of alternatives was obtained using Eq. (10). The distance matrix of alternatives is shown in Table 11.

Table 11

Distance Matrix of Alternatives

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
A_1	-0.0238	-0.0493	-0.0526	-0.0317	-0.0719	0.0010	0.0007	-0.0293	-0.0383	-0.0412	-0.0396
A_2	-0.0008	-0.0286	-0.0141	-0.0004	0.0028	0.0010	-0.0002	-0.0030	-0.0254	-0.0431	-0.0280
A_3	0.0220	0.0817	-0.0003	0.0187	-0.0025	-0.0045	-0.0017	0.0212	0.0461	0.2273	0.0535
A_4	-0.0079	-0.0441	0.0119	-0.0105	-0.0185	0.0010	-0.0004	-0.0099	-0.0320	-0.0320	-0.0376
A_5	0.0036	0.0361	0.0177	0.0499	0.0319	0.0010	0.0003	0.0079	0.0242	-0.0085	0.0262
A_6	0.0138	0.0306	0.0482	0.0166	0.0623	0.0001	0.0008	0.0137	0.0236	-0.0028	0.0276
A_7	-0.0032	0.0018	-0.0117	-0.0122	0.0057	0.0010	0.0012	0.0005	0.0088	-0.0182	0.0064
A_8	0.0067	0.0093	0.0231	-0.0120	0.0186	0.0010	0.0000	0.0113	0.0220	-0.0160	0.0246

Step 10: The final distance matrix was obtained using Eq. (11). Thus, the ranking of the alternatives was obtained. The final distance matrix of alternatives is shown in Table 12.

Table 12

Final Distance Matrix

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8
Y_t	-0,3759	-0,1397	0,4614	-0,1799	0,1902	0,2345	-0,0200	0,0885
Ranking	8	6	1	7	3	2	5	4

Results and Implications

This study has ranked Türkiye among the G7 in environmental performance by using the MPSI-MABAC hybrid approach. The G7 countries have set the benchmarks for sustainability with cutting-edge technologies, very strong economies, and stringent environmental regulations. They usually define the standards of renewable energy, emission reduction, and conservation at the global level. Therefore, an international comparison of Türkiye using the EPI framework will certainly offer some insights into the progress of Türkiye and areas where it needs help. Such comparisons enable policy-makers to recognize areas of strength/weakness so as to initiate better international cooperation towards enhancing Türkiye's stature in climate-related issues. Comparisons will also play a key role in the international collaboration on climate change and optimize the contribution of Türkiye to global environmental goals. In decision model a total of eleven criteria taken from EPI 2024 Climate Change part. The importance weights of the criteria were determined using the MPSI method as follows: ”Projected emissions in 2050 (C10)”, “Adjusted emissions growth rate for nitrous oxide (C5)”, “Adjusted emissions growth rate for carbon dioxide (country-specific targets) (C2)”, “Adjusted emissions growth rate for methane (C3)”, “Projected cumulative emissions to 2050 relative to carbon budget (C11)”, “GHG growth rate adjusted by per capita emissions (C9)”, “Adjusted emissions growth rate for F-gases (C4)”, “GHG growth rate adjusted by emissions intensity (C8)”, “Adjusted emissions growth rate for carbon dioxide (C1)”, “Adjusted emissions growth rate for black carbon (C6)” and “Net carbon fluxes due to land cover change (C7)” (EPI, 2024).

In the ranking, "Projected cumulative emissions to 2025 relative to carbon budget" C10 was ranked as the most important criterion, while "Net carbon fluxes due to land cover change" C7 was ranked as the least important; this is because the MPSI-MABAC methodology focuses on the assessment of the criteria in their relation with their strategic importance and role for ensuring the attainment of global objectives on climate. C10 also gives further guidance on how the country's path is compatible with the global carbon budget, underlining what this means for long-term climate stabilization. Given its direct connection to countries staying within sustainable carbon limits, it clearly guides basic policy mechanisms for achieving global climate goals. Its bigger picture of cumulative emissions also corresponds to the long-term goals of international climate policy and, therefore, is a core indicator of international and national performance (Fujimori et al., 2021). On the other hand, the C7 indicator only calculates the net carbon fluxes due to land cover change-a valuable metric, but narrower in scope according to reports. While afforestation and deforestation are very important in land management with respect to carbon sequestration, the local effects from these activities may not add up to the level of systemwide change which will be required to move beyond climate change (Li et al., 2022). For this reason, the applicability of this criterion is reduced when compared with the broad-ranging impacts of cumulative emissions. It thus follows that while C7 does have its role in the system of climate change mitigation, its position is relatively insignificant compared to the success of general global climate policy.

The ranking of the countries including Türkiye in terms of climate change performance was calculated using the MABAC method. The final ranking of the countries is as follows: “United Kingdom>Germany>France>Japan>Italy>United States>Canada>Türkiye”. According to this ranking, United Kingdom was determined as the leading country according to EPI 2024 Report followed by Germany. Türkiye was determined as the last country.

The main reason why the United Kingdom, Germany, and France take the leading positions in the index is huge success in carbon emissions reduction (Kang et al., 2020). The UK has abandoned the use of fossil fuels and heavily invested in renewable energy; it has perfectly performed the implementation of a national climate change mitigation plan. Germany proudly boasts of achieving highly developed technologies in energy efficiency and renewable energy use, in addition recording excellent success in low-carbon technology adoption. But France has optimized its nuclear power utilization to manage its emission and has been working extensively to reduce its carbon footprint.

Middle performers like Japan and Italy have weaker emission reduction processes and limitation issues in carbon emission reduction policy (Palea and Drogo, 2020; Honma et al., 2023). Japan has tussled with the implementation of sustainable energy, especially in relation to natural disasters and its nuclear energy crisis that delayed some of its initiatives. Italy has mixed performance in carbon emission reduction and delays in renewable energy transition (Krug et al., 2023). The low rankings of Canada and Türkiye can largely be attributed to their continued reliance on carbon-intensive energy sources and the slow pace of decarbonization policies relative to other countries. In Canada, the economy remains significantly tied to fossil fuel extraction and export, particularly oil sands, which contribute to persistently high per capita emissions. In Türkiye, rapid economic growth, increasing energy demand, and dependence on coal and natural gas have hindered substantial emission reductions, while the transition to renewable energy has progressed more slowly compared to leading nations. (Liu et al., 2022). Nevertheless, despite some progress, Türkiye still faces structural challenges—particularly the fact that renewables accounted for only around 42 % of total electricity generation as of July 2025 (including roughly 11.8 % from solar, 10.2 % from wind, and 13.1 % from hydroelectric sources) which indicating that both the utilization of renewable energy and the implementation of environmental policy remain insufficiently robust. (İnanç, 2025). Besides, failure to reach the goals concerning the reduction of emissions and lack of efficient nationwide measures to prevent climate change directly influences the position of Türkiye in the rating (Özdemir, 2023).

Comparative and Sensitivity Analysis for MPSI-MABAC Hybrid Method

Comparative Analysis

The consistency test will be necessary to validate and compare the results obtained by using the proposed MPSI-MABAC hybrid method for choosing the best renewable energy alternative with the results of proven and tested MCDM methods taken from the literature. This is for comparison consistency. For this reason, MPSI-MABAC hybrid method was compared with Multi-Attributive Border Approximation Area Comparison Method (MARCOS), Relative Allocation Method (RAM), Simple Additive Weighting (SAW), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Weighted Aggregated Sum Product Assessment (WASPAS) (Wang et al., 2016, Stević et al., 2020, Alrasheedi et al., 2023, Sotoudeh-Anvari; 2023, Kara et al., 2024, Radulescu and Radulescu; 2024).

Table 13

Comparative Analysis' Results

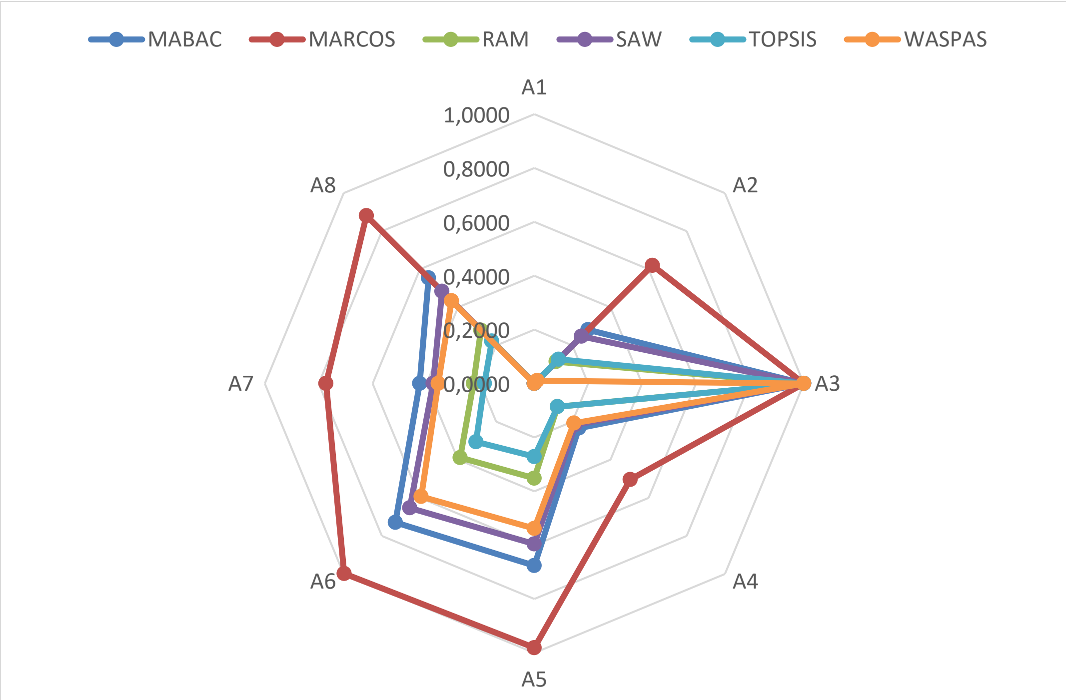
	MABAC		MARCOS		RAM		SAW		TOPSIS		WASPAS	
$\mathcal{A}_1$	0.0000	8	0.0000	8	0.0000	8	0.0000	8	0.0000	8	0.0000	8
$\mathcal{A}_2$	0.2821	6	0.6202	6	0.1151	7	0.2476	6	0.1274	6	0.0152	7
$\mathcal{A}_3$	1.0000	1	1.0000	1	1.0000	1	1.0000	1	1.0000	1	1.0000	1
$\mathcal{A}_4$	0.2341	7	0.5039	7	0.1215	6	0.2158	7	0.1217	7	0.2080	6
$\mathcal{A}_5$	0.6762	3	0.9808	3	0.3516	3	0.5958	3	0.2714	3	0.5383	3
$\mathcal{A}_6$	0.7290	2	0.9978	2	0.3888	2	0.6532	2	0.3059	2	0.5933	2
$\mathcal{A}_7$	0.4251	5	0.7727	5	0.2258	5	0.3753	5	0.1847	5	0.3564	5
$\mathcal{A}_8$	0.5546	4	0.8811	4	0.2803	4	0.4842	4	0.2230	4	0.4342	4

Ranking of the alternatives in this comparison study has been carried out by the MABAC, MARCOS, RAM, SAW, TOPSIS, and WASPAS methods (Neeraj et al., 2021). Speaking generally, all methods have ranked the United Kingdom as first, which is the most desirable alternative. On the opposite side, however, was Türkiye, ranking in the last position because it was the least desirable alternative. The intermediate positions were occupied by France, Germany, Italy, and Japan, and each method placed these alternatives nearly the same. France and Germany occupied positions 3 and 2, while Italy and

Japan were placed in positions 5 and 4, respectively. United States placed 6th under certain methods but tended to stay 7th. These results depict that these various approaches consider the nearly the same. On the other hand, all the approaches did select United Kingdom as the most preferred alternative. MABAC, in this respect, has especially been superior to the others as it takes multiple criteria into consideration more equitably and broadly. MABAC performs a boundary approximation analysis for the more precise presentation of the performance of each alternative by measuring the closeness of alternatives to the ideal solution and how much each alternative deviate from it. By this feature, United Kingdom can take precedence as the most preferred alternative. Through the MABAC method, secondly, the differences and limitations between the criteria are better managed, showing more stable and reliable rankings. Such properties render MABAC more consistent and reliable, particularly for complicated decision-making issues like the evaluation of the performance of climate change where several and sometimes contradictory criteria are taken into account. Comparative analysis results shown on Fig. 1.

Figure 1

The Comparative Analysis Results



Sensitivity Analysis

The analysis of sensitivity was done step by step to observe the stability, reliability, and robustness of the model applied in the study. In this analysis, one by one all the alternatives are eliminated, and the change in ranking of alternatives is checked to find out to which alternatives the model is sensitive. In other words, it is a sensitivity analysis where there is only one variable (alternative) that is tested as an attempt to explain the way the model output is affected (Guo and Dias, 2020). The ranking didn't change with the removal of an alternative every time. In case the ranking does not show much variation, then the model is said to be robust. From the sensitivity analysis, it was observed that with the removal of the alternatives one by one, no change in the ranking was noticed. This shows that the model is very stable, robust, and reliable.

Table 14

Sensitivity Analysis' Results

	r_t	Ranking	r_t	Ranking	r_t	Ranking	r_t	Ranking
A_1	-0.3759	8	-	-	-	-	-	-
A_2	-0.1397	6	-0.2345	6	-0.3177	6	-	-
A_3	0.4614	1	0.4169	1	0.3823	1	0.4054	1
A_4	-0.1799	7	-0.2855	7	-	-	-	-
A_5	0.1902	3	0.1670	3	0.1230	3	0.0517	3
A_6	0.2345	2	0.2486	2	0.2220	2	0.1532	2
A_7	-0.0200	5	-0.1095	5	-0.1786	5	-0.3040	5
A_8	0.0885	4	0.0427	4	-0.0086	4	-0.0950	4

	r_t	Ranking	r_t	Ranking	r_t	Ranking
A_1	-	-	-	-	-	-
A_2	-	-	-	-	-	-
A_3	0.3905	1	0.3475	1	0.3424	1
A_4	-	-	-	-	-	-
A_5	-0.0575	3	-0.1187	3	-	-
A_6	0.0711	2	-0.0316	2	-0.1708	2
A_7	-	-	-	-	-	-
A_8	-0.2050	4	-	-	-	-

Conclusions

The EPI is a comprehensive tool that evaluates countries' efforts to address environmental challenges, including climate change, air quality, biodiversity, and water resources, based on various indicators. Türkiye ranks 8th out of 8 countries in the EPI which highlights the urgent need for interventions to improve its environmental performance. The low ranking reflects significant gaps in critical areas such as emissions reduction, renewable energy adoption, and climate policy implementation, particularly in key criteria like "Projected emissions in 2050 (C10)," "Adjusted emissions growth rate for nitrous oxide (C5)," and "Adjusted emissions growth rate for carbon dioxide (C2)." These criteria are central to assessing a country's long-term climate trajectory and indicate Türkiye's insufficient progress in meeting emission reduction targets.

As a result of this study "Projected emissions in 2050 (C10)", "Adjusted emissions growth rate for nitrous oxide (C5)", "Adjusted emissions growth rate for carbon dioxide (country-specific targets) (C2)" are the most important criteria, respectively. In this context; implications have been made for government, business and researchers. These are as follows:

What is obviously required is that governments, especially in Türkiye, must develop better climate policy and strategy. Investments in renewable energy, energy efficiency, and more ambitious carbon emission reduction targets remain the sure route for Türkiye to improve its rank in climate performance and get closer to global standards. Second, international cooperation should be made a priority by governments through close interaction with several leading countries like the United Kingdom, Germany, and France. They will benefit from lessons from their state-of-the-art strategies, the sharing of best practices, and international climate agreements that will all help Türkiye devise more robust approaches. Given the projected cumulative emissions to 2025 in relation to the carbon budget C10, governments must ensure long-term strategies on emission reduction to help realize the global carbon budget and contribute to climate stabilization. However, according to the 2024 EPI report, Türkiye's projected cumulative greenhouse gas emissions by 2050 exceed the carbon budget aligned with the global 1.5°C target by approximately 44.2%. This indicates that Türkiye's current emission reduction policies are insufficient to meet international climate goals. Consequently, to achieve its net-zero target by 2053, Türkiye needs to strengthen its mitigation strategies and implement more effective climate actions to align its emissions trajectory with global climate stabilization objectives (EPI, 2024). It is important to consider the contrasting environmental policies between the Trump and Biden administrations in the USA, which may influence future rankings and emission trajectories. This study considers current policy frameworks but acknowledges that ongoing political shifts could affect the environmental performance of the USA within the G7.

Firms, particularly in both Canada and Türkiye, play a critical role in addressing climate change. Besides decreasing their individual carbon footprint, firms need to incorporate sustainable strategies into their operations that would contribute towards meeting the entire climate objectives. Low-carbon projects and energy efficiency technologies need to be prioritized to become competitive in the global market, where most countries have stringent environmental policies. Besides that, it is required to implement broader Corporate Social Responsibility policies about climate change that raise their reputation and attract climate-sensitive consumers and investors. They also need to look at investment in renewable energies and play a role in an agenda of transformation toward the green economy through the momentum that de-carbonization processes are acquiring globally.

Further research by extending the study to more criteria or to other MCDM methods might give more insightful results with regard to the best climate strategies. Policy gaps that jeopardize successful climate action, especially in countries such as Türkiye, and new policy solutions that could accelerate action-issues such as carbon tax or economic incentives for the use of renewable energies-are other subjects to which researchers should pay close attention. More research in the field of technology development, such as CCS or new renewable energy technologies, could be the basis for devising effective solutions to amplify global climate action. While this study provides valuable insights by comparing Türkiye with the G7, future research could expand the scope to include the G20 and European Union for a more comprehensive analysis, especially considering Türkiye's commitment to the EU Green Deal.

Compliance with Ethical Standards

Ethical Approval

Ethical committee approval for this study is not applicable.

Author Contributions

All authors participated equally in all aspects of the preparation of the review article, with each contributing 50% of the total effort.

Declaration of Conflicting Interests

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References

Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environ Sci Pollut Res* 29, 42539–42559. https://doi.org/10.1007/s11356-022-19718-6

Acar, E. (2022). Comparison of the performances of OECD countries in the perspective of socio-economic global indices: CRITIC-based cocoso method. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi, 73*, 256-277. https://doi.org/10.51290/dpusbe.1122650

Adebayo, T. S., Agyekum, E. B., Kamel, S., Zawbaa, H. M., & Altuntaş, M. (2022). Drivers of environmental degradation in Turkey: designing an SDG framework through advanced quantile approaches. *Energy Reports*, *8*, 2008-2021. https://doi.org/10.1016/j.egyr.2022.01.020

Ağbulut, Ü., Yıldız, G., Bakır, H., Polat, F., Biçen, Y., Ergün, A., & Gürel, A. E. (2023). Current practices, potentials, challenges, future opportunities, environmental and economic assumptions for Türkiye's clean and sustainable energy policy: A comprehensive assessment. *Sustainable Energy Technologies and Assessments*, *56*, 103019. https://doi.org/10.1016/j.seta.2023.103019

Alrasheedi, A.F., Mishra, A.R., Rani, P., Zavadskas, E. K., & Cavallaro, F. (2023). Multicriteria group decision making approach based on an improved distance measure, the SWARA method and the WASPAS method. *Granul. Comput, 8*, 1867–1885. https://doi.org/10.1007/s41066-023-00413-x

Alsanousi, A. T., Alqahtani, A. Y., Makki, A. A., & Baghdadi, M. A. (2024). A hybrid MCDM approach using the BWM and the TOPSIS for a financial performance-based evaluation of Saudi stocks. *Information*, *15*(5), 258. https://doi.org/10.3390/info15050258

Altıntaş, F. F. (2021a). Measuring the climate change protection performance of G20 group countries with ROV and MAUT methods. *Journal of Current Researches on Social Sciences*, *11*(1), 147-166. https://doi.org/10.26579/jocress.429

Altıntaş, F. F. (2021b). Çevre performanslarının ENTROPİ tabanlı ROV, ARAS ve COPRAS yöntemleri ile ölçülmesi: G20 grubu ülkeleri örneği. *Sosyal Bilimler Araştırma Dergisi*, *10*(1), 55-78. https://doi.org/10.15295/bmij.v8i4.1582

Arslan, B. (2023). *How to adapt to climate change? An analysis of ecosystem vulnerability in İzmir (Türkiye)* [Master's thesis]. Izmir Institute of Technology.

Bajdor, P., & Korpysa, J. (2025). Multi-criteria-based approach in Environmental Performance Index evaluation. *Proceedings of the 58th Hawaii International Conference on System Sciences,* 971-980

Ayçin, E., & Çakın, E. (2019). Ülkelerin çevresel performanslarının çok kriterli karar verme yöntemleri ve bulanık mantık tabanlı bir yaklaşım ile bütünleşik olarak değerlendirilmesi. *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi*, *14*(3), 631-656. https://doi.org/10.17153/oguiibf.476373

Çakmakçı, R., Salık, M. A., & Çakmakçı, S. (2023). Assessment and principles of environmentally sustainable food and agriculture systems. *Agriculture*, *13*(5), 1073. https://doi.org/10.3390/agriculture13051073

Deniz, B., Ulutürk, D., & Başkara, M. (2024). Türkiye's strides toward a greener future: National and international political progress on climate change. In Ş.N. Açıkalın & Ş.Ş. Erçetin (Eds.), *The social consequences of climate change: Debates in research and policy* (pp. 187-206). Emerald Publishing Limited.

EPI (2024) *Environmental Performance Index 2024 Report*, https://epi.yale.edu/measure/2024/EPI

Eşiyok, S., Ariş, E., & Antmen, F. (2023). Ranking and evaluation of G7 countries and Turkey by GGGI indicators using ENTROPY, CRITIC and EDAS methods. *Çukurova Üniversitesi Mühendislik Fakültesi Dergisi, 38*(3), 647-660. https://doi.org/10.21605/cukurovaumfd.1377228

Fujimori, S., Krey, V., van Vuuren, D., Oshiro, K., Sugiyama, M., Chunark, P., Limmeechokchai, B., Mittal, S., Nishiura, O., Park, C., Rajbhandari, S., Silva Herran, D., Tu, T. T., Zhao, S., Ochi, Y., Shukla, P. R., Masui, T., Nguyen, P. V. H., Cabardos, A.-M., & Riahi, K. (2021). A framework for national scenarios with varying emission reductions. *Nat. Clim. Chang., 11,* 472–480. https://doi.org/10.1038/s41558-021-01048-z

Ghaleb, A. M., Kaid, H., Alsamhan, A., Mian, S. H., & Hidri, L. (2020). Assessment and comparison of various MCDM approaches in the selection of manufacturing process. *Advances in Materials Science and Engineering, 2020*(1), 4039253. https://doi.org/10.1155/2020/4039253

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

Giovanis, E., Ozdamar, O. (2024). The transboundary effects of climate change and global adaptation: the case of the Euphrates–Tigris water basin in Turkey and Iraq. *Empir Econ, 68*, 1935–1972 https://doi.org/10.1007/s00181-024-02690-0

Gökgöz, F., & Yalçin, E. (2022). Sustainability of G20 countries within environmental and energy perspectives. *Present Environment & Sustainable Development*, *16*(2). https://doi.org/10.47743/pesd2022162010

Guo, X., & Dias, D. (2020). Kriging based reliability and sensitivity analysis–Application to the stability of an earth dam. *Computers and Geotechnics*, *120,* 103411. https://doi.org/10.1016/j.compgeo.2019.103411

Honma, S., Ushifusa, Y., Okamura, S., & Vandercamme, L. (2023). Measuring carbon emissions performance of Japan's metal industry: energy inputs, agglomeration, and the potential for green recovery reduction. *Resources Policy, 82,* 103519. https://doi.org/10.1016/j.resourpol.2023.103519

İnanç, S. (2025, July). *Türkiye's electricity production* [Turkey's electricity production]. Enerji Ajansı. https://enerjiajansi.com.tr/turkiyenin-elektrik-uretimi/ *(Accessed August 11, 2025)*

Kang, M., Zhao, W., Jia, L., & Liu, Y. (2020). Balancing carbon emission reductions and social economic development for sustainable development: Experience from 24 countries. *Chin. Geogr. Sci., 30*, 379–396. https://doi.org/10.1007/s11769-020-1117-0

Kara, K., Yalçın, G. C., Simic, V., Önden, İ., Edinsel, S., & Bacanin, N. (2024). A single-valued neutrosophic-based methodology for selecting warehouse management software in sustainable logistics systems. *Engineering applications of artificial intelligence*, *129,* 107626. https://doi.org/10.1016/j.engappai.2023.107626

Karahan, M., Yıldırım, Z., & Yıldırım, T. (2025). Comparative analysis of Turkey's environmental performance with Eastern European countries according to international EPI 2022 data. *Green Technologies and Sustainability*, *3*(1), 100116. https://doi.org/10.1016/j.grets.2024.100116

Kemp, L., Xu, C., Depledge, J., Ebi, K. L., Gibbins, G., Kohler, T. A., Rockström, J., Scheffer, M., Schellnhuber, H. J., Steffen, W., & Lenton, T. M. (2022). Climate endgame: Exploring catastrophic climate change scenarios. *Proceedings of the National Academy of Sciences*, *119*(34), e2108146119. https://doi.org/10.1073/pnas.2108146119

Khanna, M., Gusmerotti, N. M., & Frey, M. (2022). The relevance of the circular economy for climate change: an exploration through the theory of change approach. *Sustainability*, *14*(7), 3991. https://doi.org/10.3390/su14073991

Kısa, A. C. G. (2022). A multi-criteria decision making approach for evaluating environmental performances of OECD countries. İyit N., Özbek Hastaoğlu B., Toptaş A. (Ed) *Current Research in Social, Human and Administrative Sciences* (pp. 231-246).

Krug, M., Di Nucci, M. R., Schwarz, L., Alonso, I., Azevedo, I., Bastiani, M., Dyląg, A., Laes, E., Hinsch, A., Klāvs, G., Kudreņickis, I., Maleki, P., Massa, G., Meynaerts, E., Pappa, S., & Standal, K. (2023). Implementing European Union provisions and enabling frameworks for renewable energy communities in nine countries: Progress, delays, and gaps. *Sustainability*, *15*(11), 8861. https://doi.org/10.3390/su15118861

Köse, E., Aksoy, E., & Gürbüz, C. (2024). An analysis of climate change performances of the G-20 countries. *Uluslararası İşletme, Ekonomi ve Yönetim Perspektifleri Dergisi*, *8*(1), 75-102. http://dx.doi.org/10.29228/ijbemp.75734

Li, Y., Brando, P.M., Morton, D.C., Lawrence, D.M., Yang, H., & Randerson, J.T. (2022). Deforestation-induced climate change reduces carbon storage in remaining tropical forests. *Nat Commun* 13, 1964. https://doi.org/10.1038/s41467-022-29601-0

Liu, Z., Saydaliev, H. B., Lan, J., Ali, S., & Anser, M. K. (2022). Assessing the effectiveness of biomass energy in mitigating CO2 emissions: Evidence from Top-10 biomass energy consumer countries. *Renewable Energy*, *191*, 842-851. https://doi.org/10.1016/j.renene.2022.03.053

Mohaghar, A., Amiri, K., Ghasemi, R., & Azani, M. (2018*). Prioritizing the OECD countries based on environmental performance index indicators*. In International Conference on Law, Management, Business, Economics and CSR Dubai_2018

Muluneh, M.G. (2021). Impact of climate change on biodiversity and food security: A global perspective—a review article. *Agric & Food Secur, 10*, 36. https://doi.org/10.1186/s40066-021-00318-5

Neeraj, Goraya, M.S. & Singh, D. (2021). A comparative analysis of prominently used MCDM methods in cloud environment. *J Supercomput, 77,* 3422–3449. https://doi.org/10.1007/s11227-020-03393-w

Newell, P., Srivastava, S., Naess, L. O., Torres Contreras, G. A., & Price, R. (2021). Toward transformative climate justice: An emerging research agenda. *Wiley Interdisciplinary Reviews: Climate Change*, *12*(6), e733. https://doi.org/10.1002/wcc.733

Ozdemir, A. C. (2023). Decomposition and decoupling analysis of carbon dioxide emissions in electricity generation by primary fossil fuels in Turkey. *Energy*, *273*, 127264. https://doi.org/10.1016/j.energy.2023.127264

Palea, V., & Drogo, F. (2020). Carbon emissions and the cost of debt in the eurozone: The role of public policies, climate-related disclosure and corporate governance. *Business Strategy and the Environment*, *29*(8), 2953-2972. https://doi.org/10.1002/bse.2550

Palea, V., & Drogo, F. (2020). Carbon emissions and the cost of debt in the eurozone: The role of public policies, climate-related disclosure and corporate governance. *Business Strategy and the Environment*, *29*(8), 2953-2972. https://doi.org/10.1016/j.eswa.2014.11.057

Puška, A., Hodžić, I., Štilić, A., & Murtič, S. (2024). Evaluating European Union countries on climate change management: A fuzzy MABAC approach to the Climate Change Performance Index. *J. Green Econ. Low-Carbon Dev*, *3*(1), 15-25. https://doi.org/10.56578/jgelcd030102

Radulescu, C. Z., & Radulescu, M. (2024). A hybrid group multi-criteria approach based on SAW, TOPSIS, VIKOR, and COPRAS methods for complex IoT selection problems. *Electronics*, *13*(4), 789. https://doi.org/10.3390/electronics13040789

Senir, G. (2024). Evaluation of the environmental sustainability performance of Eastern European countries with integrated MCDM methods. *International Journal of Agriculture Environment and Food Sciences*, *8*(2), 378-391. https://doi.org/10.31015/jaefs.2024.2.13

Sotoudeh-Anvari, A. (2023). Root Assessment Method (RAM): A novel multi-criteria decision making method and its applications in sustainability challenges. *Journal of Cleaner Production*, *423*, 138695. https://doi.org/10.1016/j.jclepro.2023.138695

Stević, Ž., Pamučar, D., Puška, A., & Chatterjee, P. (2020). Sustainable supplier selection in healthcare industries using a new MCDM method: Measurement of alternatives and ranking according to Compromise solution (MARCOS). *Computers & industrial engineering*, *140*, 106231. https://doi.org/10.1016/j.cie.2019.106231

Taneja, S., & ÖZEN, E. (2023). Impact of the European Green Deal (EDG) on the agricultural carbon (CO2) emission in Turkey. *International Journal of Sustainable Development and Planning*, *18*(3). https://doi.org/10.18280/ijsdp.180307

Usubiaga-Liaño, A., & Ekins, P. (2021). Monitoring the environmental sustainability of countries through the strong environmental sustainability index. *Ecological Indicators*, *132*, 108281. https://doi.org/10.18280/ijsdp.180307

Wang, P., Zhu, Z., & Wang, Y. (2016). A novel hybrid MCDM model combining the SAW, TOPSIS and GRA methods based on experimental design. *Information sciences*, 345, 27-45. https://doi.org/10.1016/j.ins.2016.01.076

Wang, W., Imran, M., Ali, K., & Sattar, A. (2024, February). Green policies and financial development in G7 economies: An in-depth analysis of environmental regulations and green economic growth. In *Natural Resources Forum*. Oxford, UK: Blackwell Publishing Ltd. https://doi.org/10.1111/1477-8947.12424

Xu, Y., Umar, M., Kirikkaleli, D., Adebayo, T. S., & Altuntaş, M. (2022). Carbon neutrality target in Turkey: measuring the impact of technological innovation and structural change. *Gondwana Research*, *109*, 429-441. https://doi.org/10.1016/j.gr.2022.04.015

Zewdu, D., Krishnan, C.M., Raj, P.P.N., Makadi, Y.C., & Arlikatti, S. (2024). Assessing climate change risks using multi-criteria decision-making (MCDM) techniques in Raichur Taluk, Karnataka, India. *Stoch Environ Res Risk Assess, 38,* 4501–4526. https://doi.org/10.1007/s00477-024-02816-x

Zhao, J., Rahman, S.u., Afshan, S., Ali, M.S.E., Ashfaq, H., & İdrees, S. (2023). Green investment, institutional quality, and environmental performance: evidence from G-7 countries using panel NARDL approach. *Environ Sci Pollut Res, 30,* 100845–100860. https://doi.org/10.1007/s11356-023-29332-9