# Comparative Sustainability Rankings in Europe: Integrating SDG Index Scores with MCDM-Based Evaluations

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## Abstract

This study aims to assess and compare the sustainability performance of European countries using three well-established Multi-Criteria Decision-Making (MCDM) methods: TOPSIS, VIKOR, and COPRAS. A comprehensive set of sustainability-related indicators was selected and grouped into three key dimensions: environmental, social, and Governance. Rankings were calculated both for each dimension and for the integrated dataset combining all indicators. The results reveal that rankings derived from the social and Governance dimensions tend to have a stronger influence on the overall sustainability scores, likely due to higher consistency within these categories. From a methodological perspective, TOPSIS and VIKOR produced comparable results in most dimensions, whereas COPRAS displayed greater divergence, especially in the social dimension. The final rankings were also compared with the Sustainable Development Goals (SDG) Index to evaluate the alignment between conventional composite indices and MCDM-based approaches. For several countries—such as Albania, Bosnia, and Turkey—the MCDM-based rankings closely matched those of the SDG Index. These findings suggest that MCDM methods are not only suitable for sustainability evaluation but also offer a flexible and transparent alternative to existing global indices. Future research could explore additional indicators and incorporate alternative MCDM techniques to enhance comparative sustainability assessments.

## 1. Introduction

In recent decades, the concept of sustainability has emerged as a central concern in global policy, academia, and business strategy, primarily due to rising environmental challenges, growing socio-economic inequalities, and the pursuit of long-term development. At its core, sustainability refers to the principle of meeting the needs of the present generation without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development [WCED], 1987). The significance of sustainability lies in its integrative approach to addressing interdependent environmental, economic, and social issues that, if unaddressed, pose serious risks to global well-being and security.

The importance of sustainability cannot be overstated. On the environmental front, increasing evidence of climate change, biodiversity loss, and pollution underscores the urgency of reducing ecological degradation and ensuring the resilience of natural systems (Rockström et al., 2009). Economically, sustainability is tied to innovation, resource efficiency, stable infrastructure, and equitable economic opportunities that foster long-term growth and reduce poverty (Barbier & Burgess, 2017). Socially, sustainable development promotes inclusion, education, healthcare, justice, and institutional trust—essential components for thriving societies (Mensah, 2019).

Recognizing this multidimensionality, sustainability is commonly conceptualized around the three pillars—environmental, economic, and social (Purvis, Mao, & Robinson, 2019).

- The environmental pillar emphasizes natural resource management, climate mitigation, and ecosystem protection.
- The economic pillar relates to stable economic systems, efficient production, job creation, and technological advancement.
- The social pillar includes equity, human rights, education, health, and community development (Kuhlman & Farrington, 2010).

To promote sustainability at a global scale, the United Nations adopted the 2030 Agenda for Sustainable Development, which consists of 17 Sustainable Development Goals (SDGs) and 169 targets. These goals serve as a universal framework to guide national policies, measure progress, and align international cooperation (United Nations, 2015). Countries are now regularly assessed using global sustainability indices such as the SDG Index (Sachs et al., 2023), Environmental Performance Index (EPI) (Wendling et al., 2020), and OECD Green Growth Indicators, all of which aim to quantify how well nations are progressing toward sustainability targets.

However, measuring sustainability is inherently complex due to the diversity of indicators, subjective weighting schemes, and methodological limitations. These indices typically rely on composite scoring systems that aggregate performance across dozens of indicators, such as:

- $CO_2$ emissions per electricity output, reflecting environmental efficiency (IEA, 2023)
- PM2.5 concentrations, indicating air quality and public health (WHO, 2021)
- Under-5 mortality rate, as a proxy for child welfare and healthcare access (UNICEF, 2023)
- Homicide rates, reflecting safety and institutional stability (UNODC, 2022)
- Maternal mortality, and property rights protection, for social justice and governance (Fraser Institute, 2022)

(Mazziotta & Pareto, 2013; Bohringer & Jochem, 2007)

While these indices are useful for summarizing complex data and enabling comparisons, they are sometimes criticized for lacking methodological transparency, applying arbitrary weights, and imposing fixed aggregation logic that may not reflect regional or contextual priorities (Saltelli, 2007). As an alternative, Multi-Criteria Decision-Making (MCDM) methods have gained traction in sustainability research. MCDM techniques allow researchers to evaluate alternatives based on multiple conflicting criteria, incorporate stakeholder preferences, and generate rankings that are more transparent, flexible, and theoretically grounded (Cinelli, Kadziński, Gonzalez, & Słowiński, 2021).

In this study, we aim to evaluate and compare the existing sustainability rankings of European countries—as defined by global indices—with rankings generated through MCDM-based evaluation, using a tailored set of sustainability indicators. By doing so, we explore whether current global indices adequately reflect the sustainability performance of countries or if alternative decision-making approaches provide significantly different perspectives.

## 2. Literature review

As sustainability has become a core objective in global governance, researchers have sought to measure, rank, and compare the sustainability performance of countries through various methodologies. One prominent approach involves the use of composite indices, such as the Sustainable Development Goals (SDG) Index (Sachs et al., 2023) and the Environmental Performance Index (EPI) (Wendling et al., 2020). These indices aggregate dozens of indicators across environmental, economic, and social domains into a single numerical score to assess a country's progress toward sustainability. However, despite their utility, these indices have been frequently criticized for methodological shortcomings. For instance, Bohringer and Jochem (2007) investigated the construction of over 30 sustainability indices and found that many lacked conceptual coherence, used arbitrary weighting schemes, and failed to provide transparent justifications for aggregation methods. Their study aimed to evaluate the "measurability" of sustainability and highlighted how different choices in index construction could yield significantly divergent country rankings. They concluded that while indices serve communicative and policy roles, their analytical robustness remains questionable.

To address these methodological limitations, several scholars have turned to Multi-Criteria Decision-Making (MCDM) methods, which allow for more flexible and transparent sustainability evaluations. Cinelli et al. (2021) provided a comprehensive taxonomy of MCDM methods and discussed their application in complex decision environments such as sustainability. Their review, which included over 150 studies, emphasized that MCDM techniques such as TOPSIS, VIKOR, and AHP can accommodate multiple conflicting criteria, integrate expert opinion, and provide sensitivity analysis—advantages rarely available in standard index-based rankings. The authors concluded that MCDM methods offer a more theoretically grounded alternative to traditional indices, especially when prioritization and trade-offs between sustainability dimensions are necessary.

One example of MCDM applied to sustainability evaluation is the study by Kaya and Kahraman (2011), who used a fuzzy AHP approach to assess Turkey's energy sustainability. Their objective was to account for both quantitative factors (such as resource availability and emissions) and qualitative judgments (such as policy risk and technological maturity). They found that renewable energy sources ranked higher in sustainability when stakeholder preferences and long-term environmental impact were included in the analysis. This demonstrated the capacity of fuzzy MCDM models to accommodate uncertainty and qualitative information in sustainability assessments.

In another application, Afshari, Mojahed, and Yusuff (2010) utilized the Simple Additive Weighting (SAW) method—an MCDM variant—to rank countries by their environmental and economic performance. Their study revealed that countries with high economic development did not always rank highest in sustainability when environmental criteria were emphasized. The authors concluded that traditional economic indicators could misrepresent true sustainability performance unless integrated with ecological metrics.

Bilgili, Koçak, and Bulut (2021) conducted a comparative study of OECD countries in which they applied both TOPSIS and VIKOR methods to sustainability data and compared the results to the rankings produced by the SDG Index. Their research aimed to identify whether different evaluation methods would produce consistent country rankings. They found significant variation between the SDG Index and MCDM-based rankings, particularly for countries in the middle range. The study emphasized that MCDM allows for more nuanced interpretations of performance and could uncover overlooked strengths or weaknesses in national policies.

Similarly, Herva and Roca (2013) focused on the limitations of aggregated indices in capturing sustainability trade-offs. Their study proposed combining MCDM with life cycle analysis to better account for environmental burdens. Applying this framework to corporate sustainability evaluations, they found that MCDM models offered more diagnostic precision than simple aggregated scores, especially when evaluating alternatives with similar overall index values.

Kumar and Jha (2017) employed the VIKOR method to evaluate the social sustainability performance of Indian states. Their objective was to assess health, education, and security indicators while incorporating decision-makers' risk preferences into the analysis. The results demonstrated that rankings were sensitive to the choice of weights and distance measures, highlighting the need for sensitivity testing in composite sustainability models.

A broader review of MCDM applications in environmental and sustainability contexts was conducted by Huang, Keisler, and Linkov (2011), who examined ten years of MCDM research in environmental sciences. Their analysis showed a steady increase in the use of MCDM methods for complex planning and policy decisions. They identified that while most applications used standard models like AHP and TOPSIS, there was an increasing trend toward hybrid models that combined fuzzy logic or machine learning techniques.

On the topic of indicator design, Saltelli (2007) provided a critical examination of composite indicators used in sustainability and governance. His work pointed out that the aggregative nature of indices often conceals the uncertainty embedded in the data and methods. He advocated for the adoption of multi-criteria frameworks that allow decision-makers to interrogate the assumptions behind index construction, including compensability and weighting.

Akbar et al. (2022) developed a hybrid MCDM model to rank Sustainable Development Goals (SDGs) themselves, aiming to identify which goals should be prioritized in low-income countries. Using a combination of fuzzy AHP and entropy-based weighting, the study found that goals related to health, clean water, and education consistently emerged as the most urgent. The researchers argued that prioritization frameworks could improve the effectiveness of sustainability policy, particularly when resources are constrained.

Finally, Mardani et al. (2015) conducted an extensive literature review of MCDM applications in renewable energy and sustainability evaluation. They catalogued over 200 studies and classified them based on methodology, criteria used, and geographical focus. Their findings revealed that MCDM approaches are particularly well suited for sustainability problems that involve trade-offs between environmental protection and economic development. The authors concluded that future research should move toward hybrid and dynamic MCDM models to better capture the evolving nature of sustainability challenges.

This wide array of studies demonstrates that MCDM methods offer a powerful and credible alternative to traditional index-based rankings in sustainability research. They enable a more nuanced understanding of sustainability performance by accommodating context-specific priorities, reducing the arbitrariness of weight assignment, and enhancing methodological transparency. However, despite the growing use of MCDM techniques, relatively few studies have compared MCDM-generated sustainability rankings directly with existing global indices—particularly for European countries using the most recent data. This gap forms the basis for the current study, which aims to generate an alternative sustainability ranking using MCDM and evaluate its alignment with widely used global indices.

## 3. Data and Method

This study utilizes data from the Sustainable Development Report (SDR) compiled by the United Nations Sustainable Development Solutions Network (Sachs et al., 2023). The SDR dataset operationalizes the 17 Sustainable Development Goals (SDGs) through over 90 indicators covering social, environmental, and institutional dimensions of sustainability. It provides an empirically grounded, globally harmonized framework for measuring sustainability performance across nations. The SDR is considered a leading benchmark for sustainability monitoring, widely adopted in academic and policy-oriented research (Kroll et al., 2022).

To evaluate sustainability performance in Europe, we selected 24 indicators from the SDR dataset, chosen for their representativeness of the three primary dimensions of sustainability—environmental, social, and governance. These dimensions align with the "triple bottom line" concept in sustainability science, which emphasizes the interdependence of ecological integrity, human well-being, and institutional effectiveness (Purvis, Mao, & Robinson, 2019; Mensah, 2019).

The indicators were grouped thematically as follows:

Environmental Indicators

- Scarce water consumption embodied in imports ($m^3$ $H_2Oeq$/capita)
  Measures the volume of water scarcity-weighted virtual water embedded in imported goods, adjusted per capita.
- $CO_2$ emissions from fuel combustion per total electricity output ($MtCO_2$/TWh)
  Represents the carbon intensity of electricity generation, indicating how much $CO_2$ is emitted per unit of electricity produced.
- Annual mean concentration of PM2.5 (µg/$m^3$)
  Reflects the average atmospheric concentration of fine particulate matter (PM2.5), which is associated with serious health risks and air pollution.
- Production-based air pollution (DALYs per 1,000 population)
  Assesses the disease burden (in disability-adjusted life years) caused by air pollution from domestic production activities.
- $CO_2$ emissions from fossil fuel combustion and cement production ($tCO_2$/capita)
  Measures territorial $CO_2$ emissions per capita from fossil fuels and cement manufacturing.
- GHG emissions embodied in imports ($tCO_2$/capita)
  Calculates per capita greenhouse gas emissions embedded in imported goods, reflecting consumption-based responsibility.
- Mean area protected in terrestrial biodiversity sites (%)
  The average proportion of key biodiversity terrestrial areas that are legally protected by national policy.
- Mean area protected in freshwater biodiversity sites (%)
  Similar to the above, but focused on freshwater ecosystems.

Social Indicators

- Poverty headcount ratio at $3.65/day (%)
  The percentage of the population living on less than $3.65/day (2017 PPP), representing moderate poverty.
- Mortality rate, under-5 (per 1,000 live births)
  Indicates the probability that a child born in a given year will die before age five, per 1,000 live births.
- Life expectancy at birth (years)
  Average number of years a newborn is expected to live under current mortality conditions.
- Subjective well-being (average ladder score, 0–10)
  Based on Gallup World Poll data, reflects average self-reported life satisfaction on a scale from 0 (worst) to 10 (best).
- Ratio of female-to-male labor force participation (%)
  Measures gender equality in labor market access by comparing female and male labor force participation rates.
- Adjusted GDP growth index (0–100)
  An index combining GDP growth and economic resilience, scaled from 0 (worst) to 100 (best).
- Unemployment rate (% of labor force, ages 15+)
  The percentage of the labor force aged 15+ who are without work, available for work, and seeking employment.
- Population using the internet (%)
  The share of the population with access to and use of the internet.
- Mobile broadband subscriptions (per 100 population)
  Indicates the number of active mobile broadband subscriptions per 100 inhabitants.
- Articles published in academic journals (per 1,000 population)
  Research output per capita, based on indexed publications in peer-reviewed journals.

Governance (Institutional) Indicators

- Logistics Performance Index: Infrastructure Score (1–5)
  Assesses the quality of trade and transport infrastructure based on surveys with logistics professionals.
- Crime is effectively controlled (0–1)
  Measures public perception of the extent to which crime is contained, where 1 = effectively controlled.
- Corruption Perceptions Index (0–100)
  Captures expert assessments of public sector corruption; higher scores indicate lower corruption.
- Press Freedom Index (0–100)
  Evaluates the degree of freedom journalists and media have; higher values represent better press freedom.
- Access to and affordability of justice (0–1)
  Assesses whether individuals can obtain timely, fair, and affordable access to legal remedies.

- Timeliness of administrative proceedings (0–1)
  Measures the efficiency of administrative processes, especially the speed of public services and legal action.

All indicators were taken from the 2023 edition of the SDR dataset, depending on data availability. Before applying the Multi-Criteria Decision-Making (MCDM) method, all variables were normalized and aligned in direction (i.e., higher values consistently indicate better sustainability performance). This step was necessary to ensure that indicators were comparable across units, in line with standard practices in composite index construction (Bohringer & Jochem, 2007; Mazziotta & Pareto, 2013).

This dataset and variable structure provide a comprehensive and multidimensional foundation for conducting a robust MCDM-based sustainability ranking and for comparing these results with the SDG Index rankings provided by the SDR.

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), developed by Hwang and Yoon (1981), ranks alternatives based on their distance from an ideal best and ideal worst solution. The underlying principle is that the best alternative should be the one closest to the ideal solution and farthest from the negative ideal. The five steps of the method are; i) Normalize the decision matrix, ii) Apply weights to each criterion, iii) Identify ideal (best) and anti-ideal (worst) solutions, iv) Calculate the Euclidean distance of each alternative from the ideal and anti-ideal, v) Compute the relative closeness coefficient. The method ranks alternatives based on this closeness. The main advantages of the TOPSIS are Transparency, easy implementation, and widespread acceptance in sustainability assessments (Hwang & Yoon (1981)). The formulation of each steps in TOPSIS is given below.

**Step 1: Normalize the Decision Matrix**

| | |
|---|---|
| $r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} {x_{ij}}^2}$ for all i-1,…, and j=1,…, n | Equation 1 |

**Step 2: Construct the Weighted Normalized Matrix**

| | |
|---|---|
| $v_{ij} = w_j \times r_{ij}$ | Equation 2 |

**Step 3: Determine the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS)**

| | |
|---|---|
| $A^{+} = \{\langle \max v_{ij} \mid j \in J_{benefit}; min\ v_{ij} \mid j \in J_{cost} \rangle\}$<br>$A^{-} = \{\langle \min v_{ij} \mid j \in J_{benefit}; max\ v_{ij} \mid j \in J_{cost} \rangle\}$ | Equation 3 |

**Step 4: Calculate the Euclidean Distance to Ideal and Anti-Ideal**

| | |
|---|---|
| $S_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - A_j^+)^2}$ <br> $S_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - A_j^-)^2}$ | Equation 4 |

**Step 5: Compute the Relative Closeness to the Ideal Solution**

| | |
|---|---|
| $C_i = \frac{S_i^-}{S_i^+ + S_i^-}$ | Equation 5 |

**Step 6: Rank the Alternatives**

Higher $C_i$ is a better alternative.

VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje), introduced by Opricovic and Tzeng (2004), is a compromise-ranking method designed to identify a solution that provides the best balance between group utility and individual regret. It is particularly useful in situations where trade-offs between conflicting criteria must be addressed. The steps and operations in each steip is given below.

**Steps:**

1. Use min-max normalization for benefit criteria.

| | |
|---|---|
| $f_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}\ for\ benefit\ criteria$ <br> or for cost criteria <br> $f_{ij} = \frac{\max(x_i) - x_{ij}}{\max(x_j) - \min(x_j)}\ for\ cost\ criteria$ | Equation 6 |

2. Determine ideal and negative-ideal values for each criterion

| | |
|---|---|
| $f_j^* = max f_{ij},\ \ f_j^- = min\ f_{ij},$ | Equation 7 |

3. Calculate the **$S_i$ (group utility)** and **$R_i$ (individual regret)** measures.

| | |
|---|---|
| $S_i = \sum_{j=1}^{m} w_j \frac{f_j^* - f_{ij}}{f_j^* - f_j^-}\ (Group\ utility)$ | Equation 8 |

| | |
|---|---|
| $R_i = max_j \left[ w_j \times \frac{f_j^* - f_{ij}}{f_j^* - f_j^-} \right] \ (individual\ regret)$ | |

4. Compute the **$Q_i$ index**, which combines $S_i$ and $R_i$ with a decision-making weight (usually v = 0.5).

| | |
|---|---|
| $Q_i = v \times w_j \times \frac{S_i - S^*}{S^- - S^*} + (1 - v) \times \frac{R_i - R^*}{R^- - R^*}$<br>$S^* = min\, S_i\, , S^- = max\, S_i$<br>$R^* = min\, R_i\, , R^- = max\, R_i$<br>$v \in [0,1]$is the decision makers strategy weight (commonly v=0.5) | Equation 9 |

5. Rank the alternatives based on $Q_i$, $S_i$, and $R_i$.

   Lower $Q_i$ is a better alternative.

The main advantages of the VIKOR method are that it effectively handles conflicting criteria and highlights compromise solutions (Opricovic & Tzeng, 2004).

COPRAS (COmplex PRoportional Assessment) method, proposed by Zavadskas et al. (1994), ranks alternatives by simultaneously considering both benefit and cost criteria in a proportional utility model. It evaluates the relative significance and utility degree of each alternative. The application steps and formulas ara given below.

**Steps:**

1. Normalize the decision matrix.

| | |
|---|---|
| $r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}$ | Equation 10 |

2. Multiply by weights for each criterion.

| | |
|---|---|
| $v_{ij} = w_j \times r_{ij}$ | Equation 11 |

3. Separate criteria into **benefit** and **cost** types.

| | |
|---|---|
| $P_i = \sum_{j \in J_{benefit}} v_{ij}$ (sum of weighted benefit scores)<br>$N_i = \sum_{j \in J_{cost}} v_{ij}$ (sum of weighted cost scores) | Equation 12 |

4. Sum weighted normalized values for benefit and cost parts.

| $$Q_i = P_i + \frac{\min(N_i) \times \sum_{i=1}^{m} P_i}{N_i \times \sum_{i=1}^{m} N_i}$$ | Equation 13 |
|---|---|

5. Calculate **relative significance ($Q_i$)** and final utility degree.

| $$U_i = \frac{Q_i}{\max(Q_i)} \times 100$$ | Equation 14 |
|---|---|

6. Rank based on utility scores.

   Higher Ui is a better alternative.

**The Advantages of the COPRAS are that it is** a Straightforward computation, handles benefit/cost criteria distinctly, and provides final utility value for each option (Zavadskas, Kaklauskas, & Sarka, 1994).

## 4. Findings

This section presents the results of the sustainability ranking analyses conducted using three prominent Multi-Criteria Decision-Making (MCDM) methods: TOPSIS, VIKOR, and COPRAS. The rankings were generated based on a carefully selected set of sustainability-related indicators across three dimensions: environmental, social, and governance. In addition to an overall evaluation using the full set of criteria, each dimension was separately analyzed better to capture the specific sustainability profiles of European countries.

To ensure methodological consistency, all variables were normalized and classified as either benefit-type or cost-type, allowing appropriate treatment of values during the aggregation process. While the three methods yielded comparable rankings in many cases, some divergences were observed, especially across different sustainability dimensions. These differences highlight the sensitivity of country rankings to both the choice of indicators and the underlying decision-making methodology. The following subsections present the detailed rankings and interpretations based on each MCDM method and each sustainability dimension.

Table 1. The TOPSIS result of each dimension and the overall sequence

| | Environmental Dimension | | Social Dimension | | Governance Dimension | | All three Dimensions | |
|---|---|---|---|---|---|---|---|---|
| Country | TOPSIS Score | TOPSIS Rank | TOPSIS Score | TOPSIS Rank | TOPSIS Score | TOPSIS Rank | TOPSIS Score | Rank |
| Albania | 0,885 | 1 | 0,352 | 27 | 0,335 | 25 | 0,457 | 26 |
| Austria | 0,419 | 23 | 0,733 | 11 | 0,546 | 9 | 0,554 | 10 |
| Belgium | 0,369 | 24 | 0,766 | 8 | 0,521 | 11 | 0,544 | 14 |
| Bosnia & H. | 0,616 | 11 | 0,468 | 24 | 0,262 | 27 | 0,448 | 27 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bulgaria | 0,569 | 16 | 0,445 | 25 | 0,342 | 22 | 0,478 | 25 |
| Croatia | 0,702 | 4 | 0,580 | 17 | 0,437 | 14 | 0,548 | 12 |
| Czechia | 0,487 | 21 | 0,751 | 10 | 0,410 | 17 | 0,527 | 17 |
| Denmark | 0,533 | 18 | 0,808 | 3 | 0,681 | 1 | 0,657 | 1 |
| Estonia | 0,332 | 27 | 0,558 | 20 | 0,606 | 7 | 0,528 | 16 |
| Finland | 0,582 | 14 | 0,784 | 5 | 0,633 | 3 | 0,627 | 2 |
| France | 0,660 | 7 | 0,720 | 12 | 0,418 | 16 | 0,544 | 13 |
| Germany | 0,436 | 22 | 0,754 | 9 | 0,620 | 6 | 0,565 | 8 |
| Greece | 0,590 | 12 | 0,552 | 21 | 0,304 | 26 | 0,486 | 22 |
| Hungary | 0,696 | 5 | 0,534 | 22 | 0,351 | 21 | 0,503 | 20 |
| Ireland | 0,307 | 28 | 0,818 | 2 | 0,487 | 12 | 0,559 | 9 |
| Italy | 0,580 | 15 | 0,576 | 18 | 0,262 | 28 | 0,490 | 21 |
| Lithuania | 0,350 | 26 | 0,528 | 23 | 0,586 | 8 | 0,508 | 19 |
| Netherlands | 0,364 | 25 | 0,819 | 1 | 0,622 | 5 | 0,590 | 5 |
| Norway | 0,501 | 20 | 0,808 | 4 | 0,623 | 4 | 0,614 | 3 |
| Poland | 0,538 | 17 | 0,608 | 15 | 0,456 | 13 | 0,551 | 11 |
| Portugal | 0,587 | 13 | 0,621 | 14 | 0,387 | 19 | 0,513 | 18 |
| Romania | 0,694 | 6 | 0,433 | 26 | 0,374 | 20 | 0,486 | 23 |
| Slovak Republic | 0,627 | 10 | 0,562 | 19 | 0,338 | 23 | 0,485 | 24 |
| Slovenia | 0,522 | 19 | 0,767 | 7 | 0,536 | 10 | 0,589 | 6 |
| Spain | 0,708 | 3 | 0,596 | 16 | 0,405 | 18 | 0,539 | 15 |
| Sweden | 0,649 | 9 | 0,660 | 13 | 0,643 | 2 | 0,605 | 4 |
| Türkiye | 0,730 | 2 | 0,132 | 28 | 0,338 | 24 | 0,385 | 28 |
| United Kingdom | 0,654 | 8 | 0,779 | 6 | 0,435 | 15 | 0,582 | 7 |

An examination of the TOPSIS results presented in the table reveals, as expected, notable variations among the rankings derived from the environmental, social, and Governance dimensions. For countries such as Denmark, Finland, Germany, the Netherlands, Spain, and Turkey, the rankings based on social and Governance indicators differ significantly from those based on environmental indicators. Moreover, the integrated ranking—obtained by aggregating all three dimensions—tends to align more closely with the social and Governance rankings, suggesting that these two dimensions may have a stronger influence on the overall sustainability performance in the context of this study.

Table 2. The VIKOR result of each dimension and the overall sequence

| | Environmental Dimension | | Social Dimension | | Governance Dimension | | All Three Dimensions | |
|---|---|---|---|---|---|---|---|---|
| Country | VIKOR Q Score | VIKOR Rank | VIKOR Q Score | VIKOR Rank | VIKOR Q Score | VIKOR Rank | VIKOR Q Score | Rank |
| Albania | 0,000 | 1 | 0,766 | 26 | 0,862 | 23 | 0,853 | 26 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Austria | 0,799 | 22 | 0,178 | 11 | 0,339 | 2 | 0,314 | 5 |
| Belgium | 0,950 | 25 | 0,060 | 4 | 0,345 | 3 | 0,706 | 17 |
| Bosnia and Herzegovina | 0,511 | 13 | 0,645 | 22 | 0,969 | 26 | 0,869 | 27 |
| Bulgaria | 0,617 | 16 | 0,782 | 27 | 0,650 | 16 | 0,812 | 25 |
| Croatia | 0,289 | 2 | 0,423 | 15 | 0,726 | 20 | 0,510 | 8 |
| Czechia | 0,831 | 23 | 0,168 | 10 | 0,596 | 14 | 0,732 | 21 |
| Denmark | 0,710 | 18 | 0,023 | 2 | 0,381 | 5 | 0,262 | 3 |
| Estonia | 0,982 | 27 | 0,657 | 23 | 0,431 | 6 | 0,728 | 20 |
| Finland | 0,559 | 14 | 0,137 | 9 | 0,443 | 9 | 0,563 | 11 |
| France | 0,413 | 8 | 0,210 | 12 | 0,719 | 19 | 0,465 | 7 |
| Germany | 0,784 | 21 | 0,104 | 7 | 0,352 | 4 | 0,289 | 4 |
| Greece | 0,472 | 10 | 0,606 | 20 | 0,920 | 25 | 0,708 | 18 |
| Hungary | 0,293 | 3 | 0,580 | 19 | 0,727 | 21 | 0,463 | 6 |
| Ireland | 0,989 | 28 | 0,031 | 3 | 0,658 | 18 | 0,629 | 13 |
| Italy | 0,478 | 12 | 0,517 | 18 | 0,988 | 27 | 0,791 | 24 |
| Lithuania | 0,964 | 26 | 0,672 | 24 | 0,481 | 10 | 0,763 | 23 |
| Netherlands | 0,945 | 24 | 0,020 | 1 | 0,441 | 8 | 0,552 | 10 |
| Norway | 0,750 | 20 | 0,119 | 8 | 0,587 | 13 | 0,566 | 12 |
| Poland | 0,667 | 17 | 0,382 | 13 | 0,545 | 11 | 0,230 | 2 |
| Portugal | 0,719 | 19 | 0,417 | 14 | 0,869 | 24 | 0,755 | 22 |
| Romania | 0,320 | 6 | 0,756 | 25 | 0,645 | 15 | 0,702 | 16 |
| Slovak Republic | 0,432 | 9 | 0,448 | 16 | 0,652 | 17 | 0,694 | 15 |
| Slovenia | 0,566 | 15 | 0,087 | 6 | 0,218 | 1 | 0,148 | 1 |
| Spain | 0,304 | 4 | 0,641 | 21 | 0,563 | 12 | 0,714 | 19 |
| Sweden | 0,476 | 11 | 0,467 | 17 | 0,432 | 7 | 0,530 | 9 |
| Türkiye | 0,314 | 5 | 1,000 | 28 | 1,000 | 28 | 1,000 | 28 |
| United Kingdom | 0,338 | 7 | 0,082 | 5 | 0,825 | 22 | 0,645 | 14 |

The patterns observed in the TOPSIS results are similarly reflected in the findings derived from the VIKOR method. For countries such as Albania, Austria, Belgium, Croatia, Denmark, Germany, the Netherlands, Slovenia, Spain, and Turkey, the rankings based on social and Governance dimensions appear to be more dominant, and the overall VIKOR rankings—obtained by integrating all three dimensions—closely align with the rankings from these two dimensions.

Conversely, an opposite trend is noted for countries such as Belgium, Croatia, the Czech Republic, France, Hungary, and the Netherlands, where the VIKOR rankings exhibit greater similarity to the rankings based on the environmental dimension. A unique case is observed for Poland: while the rankings obtained separately from environmental, social, and Governance dimensions are relatively consistent, the integrated VIKOR ranking places Poland significantly higher, in the second position. This divergence suggests that the aggregated impact of moderately strong performance across all dimensions may have amplified the overall sustainability standing of the country.

Table 1. The COPRAS result of each dimension and the overall sequence

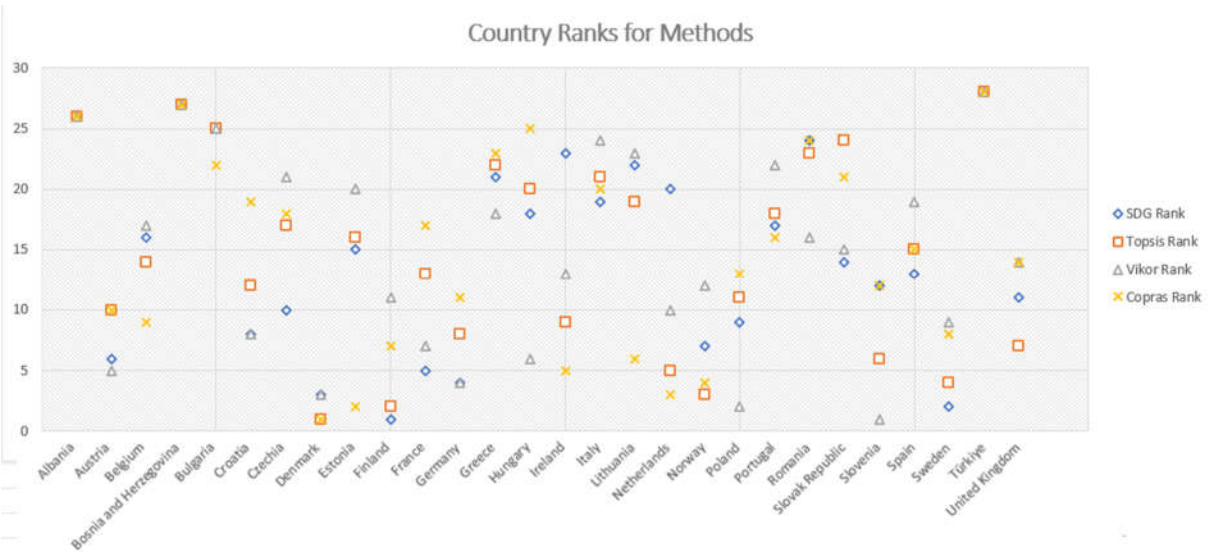
| | Environmental Dimension | | Social Dimension | | Governance Dimension | | All Three Dimensions | |
|---|---|---|---|---|---|---|---|---|
| Country | COPRAS Score | COPRAS Rank | COPRAS Score | COPRAS Rank | COPRAS Score | COPRAS Rank | COPRAS Score | Rank |
| Albania | 0 | 14 | 0,314 | 19 | 0,174 | 24 | 0,308 | 26 |
| Austria | 0 | 14 | 0,438 | 8 | 0,492 | 9 | 0,651 | 10 |
| Belgium | 0 | 14 | 0,437 | 10 | 0,462 | 11 | 0,666 | 9 |
| Bosnia and Herzegovina | 0 | 14 | 0,187 | 26 | 0,128 | 26 | 0,305 | 27 |
| Bulgaria | 0 | 14 | 0,182 | 27 | 0,226 | 22 | 0,429 | 22 |
| Croatia | 0 | 14 | 0,281 | 23 | 0,345 | 17 | 0,478 | 19 |
| Czechia | 0 | 14 | 0,344 | 17 | 0,366 | 13 | 0,486 | 18 |
| Denmark | 0 | 14 | 0,498 | 4 | 0,775 | 1 | 0,834 | 1 |
| Estonia | 0 | 14 | 0,363 | 16 | 0,604 | 6 | 0,805 | 2 |
| Finland | 0 | 14 | 0,522 | 2 | 0,663 | 4 | 0,717 | 7 |
| France | 0 | 14 | 0,463 | 7 | 0,349 | 16 | 0,498 | 17 |
| Germany | 0 | 14 | 0,403 | 14 | 0,603 | 7 | 0,647 | 11 |
| Greece | 0 | 14 | 0,337 | 18 | 0,126 | 27 | 0,422 | 23 |
| Hungary | 0 | 14 | 0,241 | 24 | 0,216 | 23 | 0,386 | 25 |
| Ireland | 0 | 14 | 0,437 | 9 | 0,467 | 10 | 0,736 | 5 |
| Italy | 0 | 14 | 0,389 | 15 | 0,154 | 25 | 0,469 | 20 |
| Lithuania | 0 | 14 | 0,304 | 21 | 0,587 | 8 | 0,724 | 6 |
| Netherlands | 0 | 14 | 0,477 | 5 | 0,638 | 5 | 0,804 | 3 |
| Norway | 0 | 14 | 0,517 | 3 | 0,693 | 2 | 0,773 | 4 |
| Poland | 0 | 14 | 0,299 | 22 | 0,359 | 15 | 0,546 | 13 |
| Portugal | 0 | 14 | 0,409 | 12 | 0,323 | 19 | 0,500 | 16 |
| Romania | 0 | 14 | 0,201 | 25 | 0,268 | 21 | 0,406 | 24 |
| Slovak Republic | 0 | 14 | 0,311 | 20 | 0,291 | 20 | 0,433 | 21 |
| Slovenia | 0 | 14 | 0,409 | 13 | 0,461 | 12 | 0,589 | 12 |
| Spain | 0 | 14 | 0,467 | 6 | 0,333 | 18 | 0,515 | 15 |
| Sweden | 0 | 14 | 0,549 | 1 | 0,681 | 3 | 0,705 | 8 |
| Türkiye | 0 | 14 | 0,063 | 28 | 0,016 | 28 | 0,175 | 28 |
| United Kingdom | 0 | 14 | 0,414 | 11 | 0,364 | 14 | 0,536 | 14 |

In the application of the COPRAS (COmplex PRoportional ASsessment) method to the environmental dimension, it was observed that several countries—such as Sweden, Spain, and Albania—received a COPRAS score of zero. This outcome is primarily due to the mathematical structure of the COPRAS formula when all or most of the criteria within a given dimension are classified as cost-type indicators.

In this study, the majority of environmental indicators (e.g., $CO_2$ emissions per electricity output, PM2.5 levels, water consumption, and GHG emissions) were treated as cost-type, meaning lower values represent better sustainability performance. After normalization and cost-benefit adjustments, countries that scored relatively worse across all or most of these cost-type indicators ended up with very low or even zero aggregated benefit values ($S^+$). Consequently, the modified COPRAS formula—which calculates scores as a function of both benefit and cost components—yields a COPRAS score of zero in such cases, reflecting an accumulated disadvantage in all environmental metrics.

This result underscores the sensitivity of the COPRAS method to the directionality (cost or benefit) and distribution of indicator values, and highlights the importance of careful indicator selection and interpretation when applying MCDM techniques to sustainability assessment.

An analysis of the COPRAS results reveals a pattern similar to those observed in the TOPSIS and VIKOR methods, whereby the rankings derived from the social and Governance dimensions exhibit a high degree of similarity. In line with this, the integrated COPRAS rankings—based on the aggregation of all three sustainability dimensions—also closely resemble the social and Governance dimension rankings, further reinforcing their dominant influence in the composite sustainability assessment.




A comparison between the rankings obtained through the TOPSIS, VIKOR, and COPRAS methods and the official SDG Index rankings reveals considerable alignment for countries such as Albania, Bosnia, Bulgaria, Denmark, Greece, Italy, Portugal, Romania, the Slovak Republic, Spain, and Turkey. In contrast, for countries like Sweden and the Netherlands, the rankings derived from the MCDM methods differ significantly from their respective SDG Index positions, indicating notable deviations in sustainability assessment outcomes depending on the evaluation framework employed.

## 5. Results and Discussion

In this study, a comprehensive set of sustainability-related indicators was employed to evaluate and compare the performance of European countries. The selected variables were grouped under three key dimensions of sustainability: environmental, social, and Governance. The environmental indicators included $CO_2$ emissions from fuel combustion per electricity output, per capita $CO_2$ emissions, PM2.5 concentration, water consumption embodied in imports, GHG emissions embodied in imports, production-based air pollution, and the share of protected terrestrial and freshwater areas. The social dimension was represented by variables such as the under-five mortality rate, maternal mortality ratio, life expectancy at birth, subjective well-being (measured via life satisfaction scores), poverty headcount ratio, female-to-male labor force participation ratio, and unemployment rate. Lastly, the Governance (governance) dimension encompassed institutional and legal quality indicators such as the control of crime, corruption perceptions index, press freedom index, perceived fairness of expropriation laws, access to and affordability of justice, and timeliness of administrative proceedings. All indicators were selected based on their relevance to the United Nations Sustainable Development Goals (SDGs) and the availability of comparable cross-country data.

In this study, sustainability-related indicators were analyzed using the TOPSIS, VIKOR, and COPRAS methods, and country rankings were obtained for each method. Additionally, sustainability indicators were categorized into environmental, social, and Governance dimensions, and rankings were calculated separately for each dimension.

The results indicate that rankings based on the social and Governance dimensions exert greater influence on the overall composite rankings. Specifically, the rankings derived from the aggregation of all indicators tend to align more closely with those obtained from the social and Governance dimensions. This outcome may be attributed to the relative similarity in the values of the indicators within the social and Governance domains, which results in greater internal consistency and stronger dominance in the overall evaluation.

From a methodological perspective, it was observed that the TOPSIS and VIKOR methods produced similar results for the environmental and social dimensions, while the COPRAS method yielded noticeably different rankings, particularly within the social dimension. In the Governance dimension, however, TOPSIS and COPRAS produced rankings that were more consistent with one another.

When comparing the rankings derived from TOPSIS, VIKOR, and COPRAS with the existing SDG Index rankings, a high degree of similarity was found for countries such as Albania, Bosnia, Bulgaria, Denmark, Greece, Italy, Portugal, Romania, the Slovak Republic, Spain, and Turkey. Notably, for Albania, Bosnia, and Turkey, all three MCDM methods produced identical rankings to those in the SDG Index. This suggests that the ranking techniques employed in this study are capable of generating results comparable to the SDG Index and may serve as valid alternative tools for sustainability assessment.

Future research could expand the scope by incorporating a broader set of SDG indicators and applying additional MCDM techniques to further evaluate and validate the robustness and applicability of these methods in sustainability measurement.

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