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Evaluation of Environmental Performance of OECD Countries Using SD-Based ARAS and WASPAS Methods

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Highlights

- This article focuses on determining the environmental performance levels of OECD countries.
- In the study, a hybrid approach proposed to determine the environmental performance.
- The results proved that this hybrid method used provides an effective decision support tool.

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Abstract

Today, industrialization and technological developments have increased rapidly. Therefore, when evaluated in terms of countries, various problems such as population growth rate, global warming, pollution, environmental destruction, waste and air pollution have become more and more important issues. Countries need to take the necessary precautions and make some improvements in order to eliminate these problems and strengthen their environmental performance. Therefore, it is important to determine the environmental performance of countries. In this context, the aim of this study is to determine the environmental performance levels of the Organization for Economic Co-operation and Development (OECD) countries using ARAS (Additive Ratio Assessment) and WASPAS (Weighted Aggregates Sum Product Assessment) methods, which are among the Multi-Criteria Decision Making (MCDM) methods. The data used within the framework of this aim was obtained from the Environmental Performance Index (2022) Report. In order to determine the environmental performance levels of countries, 10 criteria have been determined: climate change mitigation, air quality, water quality, heavy metals, waste management, biodiversity, ecosystem services, acid rain, agriculture and water resources. These criteria have been weighted with the SD (Standard Deviation) method, and rankings have been made with ARAS and WASPAS methods. The ranking results obtained from both methods have been compared. According to the SD weighting method, the criterion with the highest weight is water quality, followed by air quality and acid rain criteria. In addition, according to the results of the analysis made with ARAS and WASPAS methods, the three countries with the highest level of environmental performance in the context of 38 countries included in the analysis are Sweden, Denmark and Finland, respectively.

1. INTRODUCTION

One of the most important problems that humanity cannot prevent from encountering in the near future is undoubtedly the degradation of environmental systems and the depletion of natural resources. These two elements pose a major concern both on a global scale and at an individual level. Especially in recent years, these problems have increased and encouraged the creation of new environmental policy initiatives at both national and international levels [1]. Therefore, with environmental awareness, the demand for environmentally friendly products is increasing [2]; in recent years, interest in examining environmental problems at both micro and macroeconomic levels on a global scale has also increased [3].

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All human activities interact with the environment and have direct or indirect effects on the environment. Therefore, various efforts are needed to protect the environment so that people can survive [4]. Necessary precautions must be taken in countries. The importance given to this issue for both businesses and countries is increasing.

Environmental performance is a concept that defines business activities that meet social expectations in the creation of a friendly environment [5]. Environmental performance is defined as the measurable results of environmental management systems implemented by the business/organization based on its environmental policies and goals by ISO 14001 [6]. When the literature is examined, it is seen that the issue of environmental performance has been studied in various ways [7-11]. It is important to solve the environmental performance problem, which can be expressed as being prone to MCDM problems by nature. Environmental performance indicators contain data that can be evaluated based on criteria. In this context, MCDM methods can be used to prioritize criteria and rank alternatives (countries). With the examination of the literature, it is also seen that some of the issues on environmental performance are carried out with MCDM methods [12-14].

Decision making is defined as the process of selecting the most appropriate option for a purpose [15]. MCDM is the process of evaluating situations and analyzing multiple conflicts in making a decision [16]. In other words, MCDM methods enable the ranking of alternatives with certain criteria and the selection of the best alternative when there are multiple criteria and conflicting objectives [17]. In this context, it has been observed that the data/alternatives presented in the Environmental Performance Index (EPI 2022)) Report can be analyzed with MCDM methods.

The OECD is the best-known organization with policies on targeting better lives. In order to achieve its goal, governments need to create an environment with adequate material living conditions, quality of life and sustainable prosperity, and try to understand the real needs of citizens [18]. Since environmental health and environmental performance constitute an important issue of the welfare level of countries, the aim of the study in this context is to evaluate the environmental performances of OECD countries using MCDM methods.

In MCDM methods, the solution is generally reached by taking into account the relative distances to the ideal positive and ideal negative solutions. Or the result is reached by comparing the benefit function values of existing solutions with the ideal positive alternative solution value. In the ARAS method, the benefit function values of the alternatives can be added to the decision problem by the decision maker. In addition, the benefit function values of the alternatives can be compared with the benefit function value of the optimal alternative. This comparison expresses the difference of the method from classical MCDM methods [19]. WASPAS method, on the other hand, can check the consistency in alternative rankings by performing sensitivity analysis within its own operation [20]. These features of the WASPAS method have helped it be accepted as an effective decision-making tool in recent years. ARAS and WASPAS methods have been used to determine the environmental performance of the countries. The SD method has been used to weight the criteria. In the SD method, the importance levels of the criteria are calculated objectively by taking into account the standard deviation value of each criterion [21]. For a problem solving process, using objective weighting methods that do not take into account the subjective judgments of decision makers in the weighting process of decision criteria is important for the reliability of the results obtained. Therefore, the SD method was preferred in weighting the criteria.

In this context, in line with the main aim of the study, the SD method was first used to weight the criteria in order to rank the 38 OECD countries [22] in the EPI (2022). After weighting the criteria, 38 countries were ranked by ARAS and WASPAS methods according to 10 criteria in the EPI (2022), *including climate change mitigation, air quality, water quality, heavy metals, waste management, biodiversity, ecosystem services, acid rain, agriculture and water resources*, and the results were compared and evaluated.

The contributions of the study to the literature can be summarized as follows:

- It is thought that this study will contribute to the literature as it is the first study in which SD, ARAS and WASPAS methods are used integratedly in the evaluation of environmental performance.
- It is seen that the EPI (2022) report does not include criterion weights in the ranking of alternatives. It is thought that the study will contribute to the literature in this respect.
- With this study, the importance taken and the work carried out by countries with a good level of environmental performance will be a guide for the countries in the lower ranks.

Based on the above explanations, the second part of the study includes a literature review on environmental performance, SD method, ARAS and WASPAS methods. In the third part of the study, information about the EPI is included. In the fourth part, information about the methodology of the research and the MCDM methods to be used in this context is included. In the fifth part, the analyzes are examined and evaluations are made in line with the analysis results. Finally, a general evaluation is made, and suggestions are presented for future studies on this subject.

2. LITERATURE REVIEW

When the literature is examined, it is seen that various studies have been carried out using the SD method, ARAS and WASPAS method. Within the scope of this study, the literature has been examined in two parts: "Some studies on environmental performance" and "some studies on SD, ARAS and WASPAS methods". The review is presented in Table 1.

Table 1. *Literature review*

Author(s)	Implementation Area
Jahn [14]	In this study, the policy regimes and environmental performances of OECD countries were evaluated in terms of structural, economic, institutional and political characteristics. As a result of the study, which was analyzed with quantitative data analysis and MCDM methods, the countries closest to the ecological way of thinking and the best in terms of environmental performance were determined as the Netherlands, West Germany, Austria and Denmark. It was concluded that countries other than the 18 most developed OECD countries, including the USA, Canada, France and Australia, could not make significant progress in terms of environmental performance.
Ismail and Abdullah [23]	Within the scope of the study, a new EPI using the decision-making tool of the Analytical Hierarchy Process (AHP) is proposed. The rankings in the EPI (2012) and 9 ASEAN countries, namely Malaysia, Brunei, Thailand, Philippines, Singapore, Cambodia, Myanmar, Indonesia and Vietnam, are compared using the pairwise comparison scales in AHP. In the new ranking of ASEAN countries, Brunei has the highest value, while Singapore ranks second.
Chithambaranathan et al. [24]	In this study, a GRAY-based hybrid framework is proposed to evaluate the environmental performance of service supply chains by integrating the gray-based method with ELECTRE (The Elimination and Choice Translating Reality) and VIKOR (VlseKriterijuska Optimizacija I Komoromisno Resenje approaches). In the study, two case studies are conducted to understand the effectiveness of the criteria and method for assessing the environmental performance of service supply chains in the context of a developing country. The study concludes that organizations operating in the service sector can analyze the environmental performance of different member companies in the supply chain employed by them and obtain the ranking list of companies using the proposed framework.
Cucchiella et al. [25]	In the study, the energy and environmental performances of European countries are evaluated within the scope of sustainability. In the study, criteria are weighted with the AHP method, using Eurostat data, and a new model is proposed to rank the alternatives. As the result of the study, the top three countries with the best performance are Sweden, Denmark and Finland.
Mohaghar et al. [12]	In the study, the environmental performances of OECD countries are determined according to Entropy and TOPSIS (Technique for Order Preference by Similarity to Ideal Solutions) methods. According to the results of the analysis, Norway, Türkiye

	and Japan are in the first three countries, while Portugal, the USA and Denmark are the last countries.
Digkoglou and Papathanasiou [13]	The study aims to evaluate the environmental performance of European Union countries between 2006 and 2018 with the PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) method. As a result of the analysis conducted using the PROMETHEE method, Sweden ranked first in terms of environmental performance. In addition, the study concluded that the performance of European Union countries in recent years is quite similar in terms of environmental performance and that these countries are gradually reducing their environmental problems.
Doğan [26]	Within the scope of the study, the environmental performances of 24 OECD and EU member countries, which are among the top 50 in the context of the world ranking in Gross Domestic Product (GDP), are considered by the criteria in the Climate Change Performance Index (CCPI) and EPI. The performances are measured by CRITIC (CRiteria Importance Through Intercriteria Correlation) and MABAC (Multi-Attributive Border Approximation area Comparison methods). 2021 data is first used in the analysis, and the weights of the CCPI and EPI criteria are calculated separately with the CRITIC method. Subsequently, the environmental performances of selected countries are ranked by applying two methods: integrated CRITIC-MABAC method and criteria equally weighted-MABAC method. Finally, in the analysis, the criteria in both indices are evaluated together and the environmental performances of the countries are measured.
Senir [27]	In this study, the positions of Eastern European countries in the environmental sustainability performance index were evaluated using MCDM techniques. The Entropy method was used in the weighting of the criteria; COPRAS (Complex Proportional Assessment) and WASPAS methods were used in the environmental performance ranking. EPI (2022) was used in the study. According to the analysis results, it was determined that the criterion with the highest importance was water resources. When the rankings obtained according to the COPRAS and WASPAS methods were evaluated, it was concluded that the environmental sustainability performance rankings of the countries differed. In addition, it was determined that the WASPAS method gave more consistent results compared to the COPRAS method when compared with the index.
Kırda and Aytekin [28]	In this study, the environmental performance of industrialized countries was evaluated in the context of sustainability. The aim of the study was to identify and highlight differences in environmental protection practices. For this purpose, thirty industrialized countries were examined using a multi-criteria integrated decision model based on fourteen environmental sustainability performance criteria. A Python-based open source software that allows the use of various MCDM methods was developed for the evaluations. According to the results obtained from the developed software, Sweden ranked first in terms of environmental sustainability performance, while India ranked last.
Karahan et al. [29]	In this study, Türkiye’s environmental performance was evaluated using the Entropy-based PROMETHEE method using EPI (2022) data. Therefore, Türkiye's environmental performance was compared with Eastern European countries and evaluations were made. The study used the criteria of climate change mitigation, air quality, sanitation and drinking water, heavy metals, waste management, biodiversity and habitat, ecosystem services, fisheries, acid agriculture and water resources. According to the results of the analysis, it was concluded that Türkiye generally exhibited poor environmental performance among Eastern European countries. At the same time, it was determined that there was a need for improvement in each criterion.
	Some Studies on SD, ARAS and WASPAS Methods
Author(s)	**Implementation Area**
Karabašević et al. [30]	Within the scope of the study, the ARAS method is used for selection. The criteria are first weighted to make a choice among 4 alternatives determined in the context of 6 basic criteria. Subsequently, according to the ranking results made with the ARAS method, it is decided that choosing Alternative 2 is the most appropriate decision.
Urosevic et al. [31]	In the study, SWARA (Step-wise Weight Assessment Ratio Analysis) and WASPAS methods are used in selection for the sales manager position in the tourism sector. Within the scope of the study, SWARA weights the criteria determined as

	communication skills, leadership skills, flexibility, decision-making, negotiation skills, analytical skills and consistency; WASPAS method is used to rank the alternatives. As a result of the study, it is decided that alternative 2 is the best.
Singh and Modgil [32]	Within the scope of the study, SWARA and WASPAS methods are used in supplier selection. The SWARA method is used to weight the determined criteria, and the WASPAS method is used to rank the 5 alternatives. As a result of the analysis, Alternative 1 receives the highest value.
Sihombing et al. [33]	Within the scope of the study, 5 alternative establishment locations are compared in the context of 5 criteria: population density level, access to locations, crowd level, rental costs and population income. According to the ranking results through the ARAS method, Patuan_Anggi_Street is determined to be the most suitable establishment location.
Lukić and Zekić [34]	In this study, the efficiency of trading companies in Serbia was evaluated using the ARAS method. In the study, five criteria were weighted with AHP: number of employees, assets, capital, operating income and net income. The criterion with the highest importance level of the AHP analysis result was determined as number of employees. The ARAS method was used to evaluate the efficiency of 10 trading companies and as a result, MERCATA VT was the highest company. It was followed by DELHAIZE SERBIA, NELT CO., PHOENIX PHARMA, LIDL SRBIJA, KNEZ PETROL, AGROGLOBE, MERCATOR-S, MOL SERBIA and LUKOIL SRBIJA.
Ozceylan et al. [35]	In this study, MCDM was used in the evaluation and selection of the best device based on some new technologies (devices) evaluated within the framework of Aviation 4.0. Criteria weights were determined by FAHP (Fuzzy Analytical Hierarchy Process). WASPAS method was used in the ranking of three alternative devices. As a result of the analysis, it was concluded that the A3 (De-tector FLEX) alternative was the best alternative.
Hashim et al. [36]	Within the scope of the study, 6 green suppliers are evaluated through the ARAS method in the context of criteria determined as economy and trade, environmental, delivery, technology and quality. As a result of the analysis, it is determined that the second alternative gives the best result.
Szymczyk et al. [37]	Within the scope of the study, the entrepreneurship performances of Asia-Oceania countries are evaluated with CRITIC, ARAS, WASPAS, MAIRCA (Multi Atributive Ideal-Real Comparative Analysis) and Borda methods. Within the scope of the analysis, 34 countries are weighted and ranked according to the CRITIC method, taking into account 15 criteria between 2016-2020. In line with this, a general ranking is obtained according to the Borda method and the results are examined. Qatar, United Arab Emirates and Thailand are among the top three countries with higher levels of global entrepreneurship performance, while India, Pakistan, Japan and Malaysia are ranked the last countries.
Kökyıldırım and Antmen [38]	In this study, the financial performance of 11 electric energy companies operating in Borsa Istanbul (BIST) was evaluated in the context of 2022. Seven criteria, namely operating profitability, net profitability, current ratio, liquidity ratio, financial leverage, cash rate, return on equity, were weighted with the Entropy weighting method. The companies were ranked with the WASPAS method. As a result of the analyzes, Cash rate was determined as the highest importance criterion. It was concluded that Galata Wind Energy was the company with the best financial performance.
Yavuz and Manga [39]	In this study, the basic science and technology indicators (2022) of 28 OECD countries were evaluated with the Entropy-based WASPAS method. Within the scope of the analysis, the criteria were first weighted with the Entropy method. According to this analysis, the highest importance criterion was determined as “export market (share of computer, electronics and optics sector)”. Then, the countries were ranked with the WASPAS method in terms of science and technology indicators. According to the analysis results, the countries with the best performance in terms of basic science and technology indicators were determined as Korea, Germany, Japan, France and the Netherlands, respectively. In addition, Chile, Latvia, Luxembourg, Lithuania and Estonia ranked last, respectively.
Nugroho et al. [40]	In this study, the WASPAS method was used to determine the best wheat flour for pineapple cake production. According to the analysis results, it was determined that Bunga Sari Hana Emas had the highest score.

Hendrawan and Kom [41]	This study aims to determine the best location for a new retail branch using the WASPAS method. In the study conducted on a company, it was determined that the WASPAS method, which takes into account various normalized and weighted criteria, can provide accurate and reliable suggestions in determining the best location for a new branch.

Source: Created by the authors in line with the literature review.

3. ENVIRONMENTAL PERFORMANCE INDEX (EPI)

Environmental Performance Index evaluates the environmental results of countries according to stated policy targets [42]. The index is performance-oriented and measures environmental quality and sustainability. It also focuses on the effects of economic competition, growth, urbanization, natural resource use and other environmental pressures on environmental quality [43].

EPI (2022) provides a data-driven summary of the state of sustainability worldwide. As a composite index, the EPI (2022) includes country-level data on 40 specific indicators, from reliable sources, including non-governmental organizations and academic researchers, in order to improve the environmental performance of 180 countries. It breaks it down into 3 policy objectives and an overall EPI score, and the most appropriate road map is suggested. EPI is a powerful policy tool that supports efforts to achieve the United Nations (UN) Sustainable Development Goals and move society towards a sustainable future [44].

When the report is examined in detail, 180 countries are ranked in the context of their general and regional performance using 11 criteria including *climate change mitigation, air quality, water quality, heavy metals, waste management, biodiversity, fishery, ecosystem services, acid rain, agriculture and water resources* [44]. Within the scope of this study, 10 criteria[1] are weighted with the SD weighting method. OECD countries are ranked according to ARAS and WASPAS methods.

4. METHODOLOGY

This section contains information about the SD, ARAS and WASPAS methods used in weighting the criteria and ranking the alternatives in order to evaluate the environmental performance of OECD countries. Since the data presented in the EPI Report are deterministic data, MCDM methods are used in the study to analyze these data.

4.1. SD Method

SD method is an objective weighting method that calculates the weights of performance criteria. This method, which is developed by [21], is a reliable method that determines how much each variable deviates from its mean. SD method consists of three stages [21]:

Step 1: Creating the decision matrix

The decision matrix X= $[x_{ij}]_{m*n}$ is created as shown in Equation (1)

$$X=[x_{ij}]_{m*n} = \begin{bmatrix} x_{11} & \cdots & x_{12} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{21} & \cdots & x_{22} & \cdots & x_{2n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

x_{ij}, represents the value of the *i*th alternative in the *j*th criterion.

[1]Data on fishery is excluded since they cannot be fully obtained from the countries.

Step 2: Creating the normalized decision matrix

The values in the decision matrix are normalized by considering the benefit and cost situations. While normalizing the data, if the relevant criterion has a benefit feature for the decision maker, Equation (2) is used, and if the relevant criterion has a cost feature, Equation (3) is used.

x_j^{max} = maximum value of the *j*th criterion among the alternatives
x_j^{min}= minumum value of the *j*th criterion among the alternatives

i = 1,2, …, m (alternatives)
j= 1,2, …, n (criteria);

$$x_{ij}^* = \frac{x_{ij}-x_j^{min}}{x_j^{max}-x_j^{min}} \quad (2)$$

$$x_{ij}^* = \frac{x_j^{max}-x_{ij}}{x_j^{max}-x_j^{min}} \quad (3)$$

x_{ij}^*, represents the normalized value of the *i*th alternative in terms of the *j*th criterion.

Step 3: Calculating criterion weights

In the last step of the SD method, the weight of each criterion is calculated with Equation (4).

$$w_j = \frac{\sigma_j}{\sum_{j=1}^{n}\sigma_j} \ , \quad j = 1,2, \ldots m. \quad (4)$$

The σ_j value in Equation (4) is the standard deviation value of the *j*th criterion.

4.2. ARAS Method

The ARAS method has been put forward by [45] as an effective and easily applicable method in solving MCDM problems. The method consists of four steps [45]:

Step 1: Creating the decision matrix

There is a separate row in the decision matrix that is added by the decision maker and contains the optimal values for each criterion.

Depending on whether the criterion has a benefit or cost feature, the optimal value is represented by Equations (5) and (6).

Benefit criterion;

$$x_{0j} = max_i x_{ij} \quad (5)$$

Cost criterion;

$$x_{0j} = min_i x_{ij} \quad (6)$$

***Step 2*:** Creating the normalized decision matrix

In the ARAS method, the $\bar{X}$ normalized decision matrix consists of $\bar{x}_{ij}$ values. $\bar{x}_{ij}$ values are expressed depending on whether the criterion has a benefit or cost feature. If the criterion values are considered to have more beneficial features, the normalized values are calculated with Equation (7)

$$\bar{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}} . \quad (7)$$

If it is considered more beneficial that the criterion performance values have cost characteristics, the normalization process is calculated with Equations (8) and (9)

$$x_{ij}^{*} = \frac{1}{x_{ij}} ; \quad (8)$$

$$\bar{x}_{ij} = \frac{x_{ij}^{*}}{\sum_{i=0}^{m} x_{ij}^{*}} . \quad (9)$$

Step 3: Creating the weighted normalized decision matrix

$\bar{X}$normalized decision matrix is obtained after normalizing the decision matrix with w_j weights. The weight values of the criteria meet the condition of $0 < w_j < 1$ and the sum of the weights is represented in Equation (10)

$$\sum_{j=1}^{n} w_j = 1 . \quad (10)$$

$\bar{x}_{ij}$ the weighted normalized values are calculated with Equation (11)

$$\hat{x}_{ij} = \bar{x}_{ij} . w_{ij} . \quad (11)$$

Step 4: Calculating optimal values

In the 4th step, the optimal values for each alternative are determined using Equation (12)

$$S_{i} = \sum_{j=1}^{n} \hat{x}_{ij}, \quad i = 0,1,...,m. \quad (12)$$

S_i shows the optimal function value of the *ith* alternative.

K_i benefit degrees are calculated with Equation (13).

$$K_i = \frac{S_i}{S_0}, \quad i = 0,1,...,m. \quad (13)$$

The benefit function values of the alternatives can be obtained with K_i ratios that take values between the [0,1] range. In the last step of the ARAS method, the calculated values are listed, and the alternatives are evaluated.

4.3. WASPAS Method

Zavadskas et al. developed the WASPAS method in 2012 [46]. The method is a combination of two well-known MCDM approaches, namely Weighted Sum Model (WSM) and Weighted Product Model (WPM). It is aimed to increase the ranking accuracy by using these two methods together. The method consists of six stages. These steps are as follows [47]:

Step 1: Creating the decision matrix

The WASPAS method starts with the creation of the decision matrix.
The decision matrix X= $[x_{ij}]_{m*n}$ is created as shown in Equation (14)

$$X=[x_{ij}]_{m*n}=\begin{bmatrix} x_{11} & \cdots & x_{12} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{21} & \cdots & x_{22} & \cdots & x_{2n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{m2} & \cdots & x_{mn} \end{bmatrix} \tag{14}$$

x_{ij}, represents the value of the *i*th alternative in the *j*th criterion.

Step 2: Creating the normalized decision matrix

In this step, the linear normalization process of the created decision matrix elements is calculated [20].

Benefit criterion;

$$\overline{x_{ij}} = \frac{x_{ij}}{max_i . x_{ij}} \tag{15}$$

Cost criterion;

$$\overline{x_{ij}} = \frac{min_i . x_{ij}}{x_{ij}} \tag{16}$$

Normalization is performed with Equations (15) and (16) [20].

Step 3: Calculating of the total relative importance of the *i*th alternative based on the WSM

Relative importance is calculated according to the WSM with Equation (17) [20]

$$Q_i^{(1)} = \sum_{j=1}^{n} \overline{x_{ij}} \, . \, w_j \, . \tag{17}$$

Step 4: Calculating of the total relative importance of the *i*th alternative based on the WPM

In the 4th step of the method, total relative importance values are obtained according to the WPM method [20]

$$Q_i^{2} = \prod_{j=1}^{n} \left(\overline{x_{ij}}\right)^{w_j} . \tag{18}$$

Step 5: Calculating the weighted common general criterion value of additive and multiplicative methods

In step 5, the weighted common generalized criterion values of additive and multiplicative methods are obtained by using Equation (19)

$$Q_i = 0.5Q_i^{(1)} + 0.5Q_i^{(2)} = 0.5 \sum_{j=1}^{n} \overline{x_{ij}} \, . \, w_i + 0.5 \prod_{j=1}^{n} \left(\overline{x_{ij}}\right)^{w_j} . \tag{19}$$

Step 6: Calculating the overall relative importance of the alternatives

While the alternatives are listed in the 6th step of the method, it is aimed to increase the accuracy and efficiency of the method. In this context, Equation (20) is used to determine the total relative importance of the alternatives

$$Q_i = \lambda Q_i^{(1)} + (1\text{-}\lambda) Q_i^{(2)} = \lambda \sum_{j=1}^{n} \overline{x_{ij}} \, . \, w_i + (1\text{-}\lambda) \prod_{j=1}^{n} \left(\overline{x_{ij}}\right)^{w_j} \quad (\lambda - 0, 0.1, \ldots, 1). \tag{20}$$

The alternatives used are ranked according to the Q value. When it is λ=0, the WASPAS method is converted to WPM, and when it is λ=1, the WASPAS method is converted to WSM method.

The hierarchical structure of the MCDM methods used in the study is shown in Figure 1.

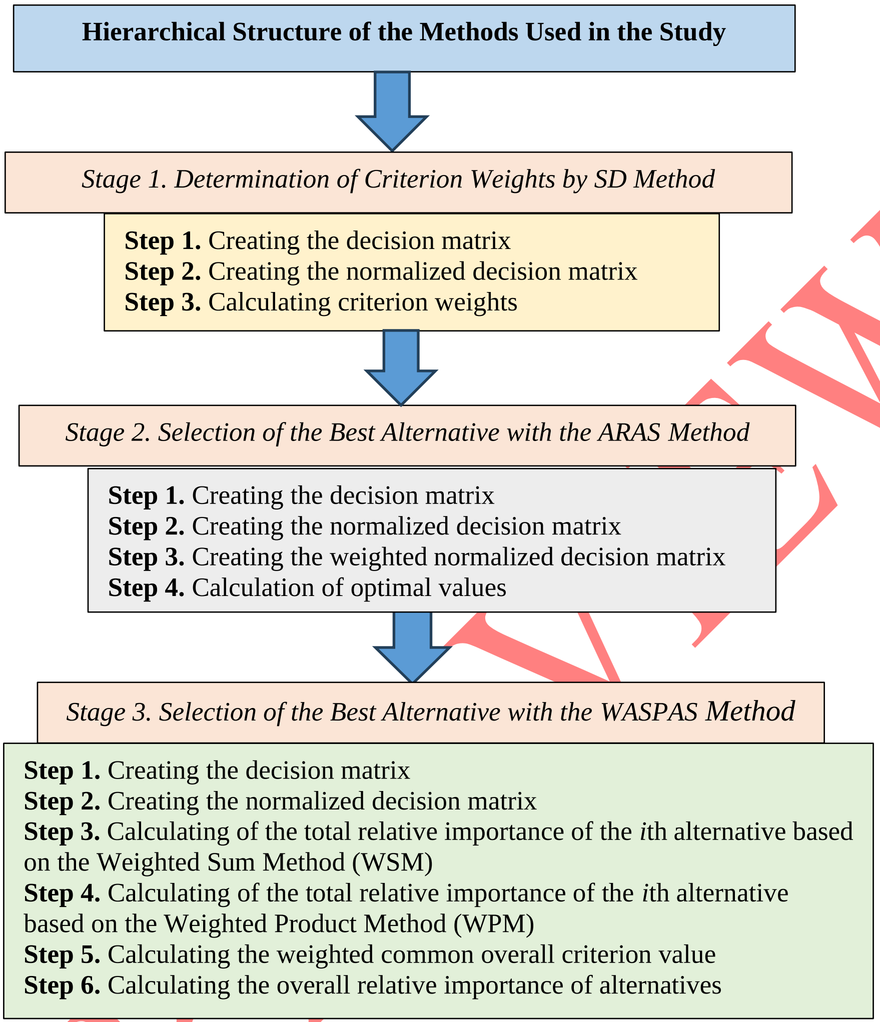

Figure 1. *Hierarchical structure of the MCDM methods used in the study*

Source: Created by the authors in line with the literature.

5. RESULTS

The aim of this study is to determine the environmental performance levels of OECD countries using ARAS and WASPAS methods, which are among the MCDM methods. The data used within the framework of this aim has been obtained from the EPI (2022) Report. In order to determine the environmental performance levels of countries, 10 criteria, including *climate change mitigation*, *air quality*, *water quality*, *heavy metals*, *waste management*, *biodiversity*, *ecosystem services*, *acid rain*, *agriculture and water resources* have been determined by examining the literature. These criteria were weighted with the SD method and rankings were made with ARAS and WASPAS methods and the ranking results obtained from these two methods were compared.

The criteria, the codes of the criteria and the objectives (maximum and minimum status) for each criterion are shown in Table 2.

Table 2. *Criteria, codes and purpose used in the evaluation*

Criteria	Code	Criteria: Benefit (+)/ Cost (-)
Climate Change Mitigation	C1	+
Air Quality	C2	+
Water Quality	C3	+
Heavy Metals	C4	-
Waste Management	C5	+
Biodiversity	C6	+
Ecosystem Services	C7	+
Acid Rains	C8	-
Agriculture	C9	+
Water Resources	C10	+

5.1. Implementation of the SD Method

SD method has been used to weight the criteria in the study. Below are the implementation stages of the SD method.

Step 1: Creating the decision matrix

The data used in the decision matrix has been obtained from the EPI (2022) Report. The decision matrix for the 10 criteria and 38 alternatives used in the study is shown in Table 3.

Table 3. *Decision matrix*

Countries	Criteria									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Australia	43.8	91.1	87.1	76.4	69.0	82.1	20.1	88.6	67.9	92.9
Austria	50.3	75.0	94.7	90.7	77.4	86.0	28.0	100.0	70.6	94.0
Belgium	48.1	74.6	93.6	66.6	68.0	82.4	16.3	100.0	33.1	68.2
Canada	28.2	88.0	88.1	95.6	59.5	62.9	29.8	100.0	42.1	67.4
Chile	35.8	48.4	68.1	96.8	46.4	61.3	28.4	74.6	47.4	71.9
Colombia	30.2	44.0	55.9	61.1	60.3	77.4	30.6	52.0	31.2	25.9
Costa Rica	41.5	51.4	66.2	53.1	52.5	68.5	22.9	84.2	21.8	7.2
Czechia	52.8	53.3	76.5	75.5	74.9	83.3	19.1	100.0	37.4	61.5
Denmark	92.4	80.5	97.5	100.0	68.3	76.9	16.4	100.0	75.7	100.0
England	91.5	78.6	100.0	93.6	62.6	81.5	23.6	100.0	45.0	99.0
Estonia	52.0	74.6	61.9	86.5	66.7	86.0	15.2	100.0	61.8	70.4
Finland	83.6	93.5	100.0	100.0	69.6	71.1	20.1	100.0	62.7	100.0
France	49.5	82.0	96.3	83.1	63.8	86.5	21.5	100.0	49.5	88.0
Germany	47.2	75.2	99.1	89.8	69.0	88.5	17.9	100.0	60.9	97.0
Greece	50.8	62.0	98.2	68.6	59.9	69.1	28.1	78.7	38.9	81.7
Hungary	48.1	38.2	62.2	67.4	43.4	78.0	28.0	100.0	53.0	55.3
Iceland	56.4	96.0	100.0	95.1	73.9	57.0	77.4	95.8	18.5	15.3
Ireland	48.2	89.1	97.4	81.8	67.9	59.6	17.4	95.4	48.7	87.0
Israel	39.8	68.0	92.9	91.1	62.7	39.7	42.2	58.5	28.8	81.7
Italy	48.2	69.4	98.3	80.6	60.6	76.5	26.1	100.0	38.8	58.8
Japan	41.2	78.9	95.1	100.0	52.8	80.8	26.8	100.0	33.4	74.8
Latvia	58.6	51.1	59.1	77.5	63.0	84.3	15.8	95.0	64.4	90.7
Lithuania	47.1	58.4	58.4	83.0	67.4	84.4	21.9	95.5	65.6	52.3
Luxembourg	67.4	81.0	98.7	95.1	79.1	84.8	18.1	100.0	55.9	98.0
Mexican	38.9	34.2	52.9	45.1	43.5	69.8	32.7	90.1	50.6	25.2
Netherlands	54.5	76.8	100.0	94.1	66.2	80.1	24.4	100.0	29.3	100.0
New Zeland	40.4	93.2	80.4	74.6	60.9	76.6	26.9	76.0	64.9	79.9

Norway	43.9	92.4	100.0	93.0	70.7	71.2	30.8	100.0	25.5	64.3
Poland	38.8	40.4	71.8	64.5	63.7	87.3	17.7	99.6	42.7	61.5
Portugal	37.6	78.1	83.5	64.6	62.5	70.5	8.6	100.0	23.5	59.2
Republic of Korea	30.9	62.9	90.8	88.4	72.0	61.0	17.7	84.3	44.1	76.8
Slovakia	53.5	50.9	71.9	68.4	62.2	82.7	19.9	100.0	68.0	44.7
Slovenia	62.9	55.1	74.7	87.2	66.7	84.5	34.1	100.0	55.0	92.2
Spain	41.3	74.0	96.9	70.5	61.4	85.8	13.4	100.0	31.8	91.1
Sweden	75.4	94.0	98.6	96.9	70.8	68.8	29.3	100.0	74.0	100.0
Switzerland	60.5	84.3	100.0	94.0	76.4	62.5	30.7	100.0	41.1	97.0
Türkiye	21.5	44.6	52.7	60.8	40.6	7.5	22.0	61.8	39.1	30.5
USA	37.2	77.0	86.1	75.1	54.3	60.6	20.1	100.0	61.4	58.9

Step 2: Normalizing the decision matrix

The normalization process of the decision matrix has been done according to Equations (2) and (3), and is shown in Table 4.

Table 4. *Calculation of the normalized decision matrix*

Countries	**Criteria**									
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
Australia	0.3145	0.9207	0.7272	0.4298	0.7376	0.9209	0.1671	0.2375	0.8636	0.9234
Austria	0.4062	0.6601	0.8879	0.1693	0.9558	0.9691	0.2819	0	0.9108	0.9353
Belgium	0.3751	0.6537	0.8646	0.6083	0.7116	0.9246	0.1119	0	0.2552	0.6573
Canada	0.0944	0.8705	0.7484	0.0801	0.4909	0.6839	0.3081	0	0.4125	0.6487
Chile	0.2016	0.2297	0.3255	0.0582	0.1506	0.6641	0.2877	0.5291	0.5052	0.6971
Colombia	0.1227	0.1585	0.0676	0.7085	0.5116	0.8629	0.3197	1	0.2220	0.2015
Costa Rica	0.2820	0.2783	0.2854	0.8542	0.3090	0.7530	0.2078	0.3291	0.0576	0
Czechia	0.4414	0.3090	0.5031	0.4462	0.8909	0.9358	0.1526	0	0.3304	0.5851
Denmark	1	0.7491	0.9471	0	0.7194	0.8567	0.1133	0	1	1
England	0.9873	0.7184	1	0.1165	0.5714	0.9135	0.2180	0	0.4632	0.9892
Estonia	0.4301	0.6537	0.1945	0.2459	0.6779	0.9691	0.0959	0	0.7569	0.6810
Finland	0.8758	0.9595	1	0	0.7532	0.7851	0.1671	0	0.7727	1
France	0.3949	0.7734	0.9217	0.3078	0.6025	0.9753	0.1875	0	0.5419	0.8706
Germany	0.3624	0.6634	0.9809	0.1857	0.7376	1	0.1351	0	0.7412	0.9676
Greece	0.4132	0.4498	0.9619	0.5719	0.5012	0.7604	0.2834	0.4437	0.3566	0.8028
Hungary	0.3751	0.0647	0.2008	0.5938	0.0727	0.8703	0.2819	0	0.6031	0.5183
Iceland	0.4922	1	1	0.0892	0.8649	0.6111	1	0.0875	0	0.0872
Ireland	0.3765	0.8883	0.9450	0.3315	0.7090	0.6432	0.1279	0.0958	0.5279	0.8599
Israel	0.2581	0.5469	0.8498	0.1621	0.5740	0.3975	0.4883	0.8645	0.1800	0.8028
Italy	0.3765	0.5695	0.9640	0.3533	0.5194	0.8518	0.2543	0	0.3548	0.5560
Japan	0.2778	0.7233	0.8964	0	0.3168	0.9049	0.2645	0	0.2604	0.7284
Latvia	0.5232	0.2734	0.1353	0.4098	0.5818	0.9481	0.1046	0.1041	0.8024	0.8997
Lithuania	0.3610	0.3915	0.1205	0.3096	0.6961	0.9493	0.1933	0.0937	0.8234	0.4859
Luxembourg	0.6473	0.7572	0.9725	0.0892	1	0.9543	0.1380	0	0.6538	0.9784
Mexican	0.2454	0	0.0042	1	0.0753	0.7691	0.3502	0.2062	0.5611	0.1939
Netherlands	0.4654	0.6893	1	0.1074	0.6649	0.8962	0.2296	0	0.1888	1
New Zeland	0.2665	0.9546	0.5856	0.4626	0.5272	0.8530	0.2659	0.5	0.8111	0.7834
Norway	0.3159	0.9417	1	0.1275	0.7818	0.7864	0.3226	0	0.1223	0.6153
Poland	0.2440	0.1003	0.4038	0.6466	0.6	0.9851	0.1322	0.0083	0.4230	0.5851
Portugal	0.2270	0.7103	0.6511	0.6448	0.5688	0.7777	0	0	0.0874	0.5603
Republic of Korea	0.1325	0.4644	0.8054	0.2112	0.8155	0.6604	0.1322	0.3270	0.4475	0.75
Slovakia	0.4513	0.2702	0.4059	0.5755	0.5610	0.9283	0.1642	0	0.8653	0.4040
Slovenia	0.5839	0.3381	0.4651	0.2331	0.6779	0.9506	0.3706	0	0.6381	0.9159
Spain	0.2792	0.6440	0.9344	0.5373	0.5402	0.9666	0.0697	0	0.2325	0.9040
Sweden	0.7602	0.9676	0.9704	0.0564	0.7844	0.7567	0.3008	0	0.9702	1

Switzerland	0.5500	0.8106	1	0.1092	0.9298	0.6790	0.3212	0	0.3951	0.9676
Türkiye	0	0.1682	0	0.7140	0	0	0.1947	0.7958	0.3601	0.2510
USA	0.2214	0.6925	0.7061	0.4535	0.3558	0.6555	0.1671	0	0.75	0.5571

Step 3: Determining criterion weights

The criterion weights have been calculated according to Equation (4) and are shown in Table 5 and Figure 2.

Table 5. *Calculation of criterion weights*

	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
w_j	0.0886	0.1139	0.1355	0.1031	0.0957	0.0754	0.0635	0.1052	0.1097	0.1090

Source: The weighting result obtained with the SD method created by the authors.

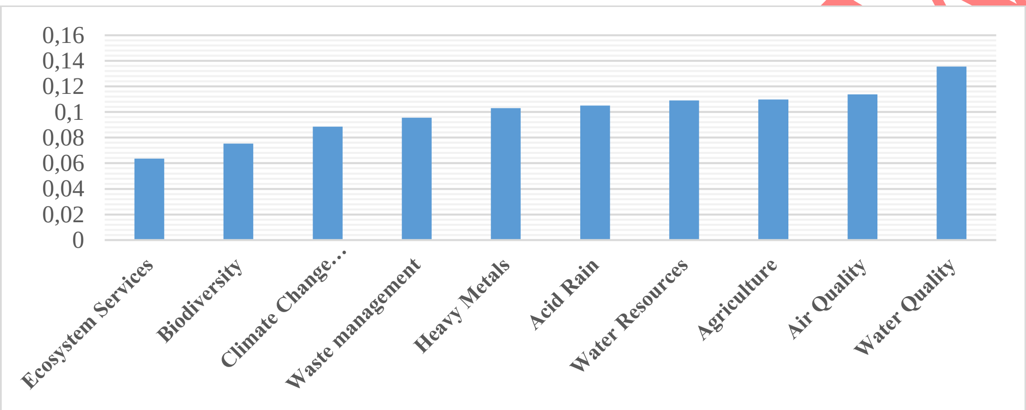

Figure 2. *Criterion weights obtained by SD method*

After the criterion weighting made with the SD method, the criterion with the highest weight among the criteria of *climate change mitigation, air quality, water quality, heavy metals, waste management, biodiversity, ecosystem services, acid rain, agriculture and water resources* has been found to be the *water quality* criterion. This criterion is followed by *air quality* and *agriculture* criteria.

4.2. Ranking of Countries' Environmental Performance Levels Using ARAS and WASPAS Methods

Countries have been ranked in terms of environmental performance levels using ARAS and WASPAS methods, based on the criterion weights obtained from the SD method. The data obtained are as shown in Table 6 and Figure 3. Solution steps for ARAS and WASPAS methods (Table A1-Table A7) are presented in the Appendix.

Table 6. *Ranking of environmental performance levels of OECD countries according to the results obtained from ARAS and WASPAS methods*

ARAS			**WASPAS**		
Countries	K_i	**Rank**	**Ülkeler**	λ	**Rank**
Australia	0.71060105	**7**	**Australia**	0.74131561	**6**
Austria	0.7188432	**4**	**Austria**	0.7486695	**4**
Belgium	0.62532575	**21**	**Belgium**	0.65411805	**17**
Canada	0.60045283	**28**	**Canada**	0.62282409	**27**
Chile	0.56333331	**33**	**Chile**	0.57756507	**33**
Colombia	0.56490848	**32**	**Colombia**	0.55217209	**35**
Costa Rica	0.50678095	**37**	**Costa Rica**	0.48078511	**37**
Czechia	0.59328813	**30**	**Czechia**	0.61833695	**28**
Denmark	0.74978498	**2**	**Denmark**	0.77029487	**2**
England	0.71568717	**5**	**England**	0.73885275	**7**
Estonia	0.62304014	**22**	**Estonia**	0.64650757	**21**

Finland	0.74012857	**3**	**Finland**	0.76579554	**3**
France	0.67222418	**11**	**France**	0.70499298	**11**
Germany	0.68704058	**10**	**Germany**	0.71977469	**9**
Greece	0.65757701	**14**	**Greece**	0.68254054	**14**
Hungary	0.56262011	**34**	**Hungary**	0.57131473	**34**
Iceland	0.65508605	**15**	**Iceland**	0.60617723	**30**
Ireland	0.66075218	**13**	**Ireland**	0.69135758	**12**
Israel	0.64457859	**17**	**Israel**	0.64850945	**20**
Italy	0.6151147	**23**	**Italy**	0.64217325	**22**
Japan	0.60553819	**26**	**Japan**	0.63153224	**24**
Latvia	0.63296207	**18**	**Latvia**	0.65038518	**18**
Lithuania	0.6005688	**27**	**Lithuania**	0.61809229	**29**
Luxembourg	0.71342923	**6**	**Luxembourg**	0.74544129	**5**
Mexican	0.55195231	**36**	**Mexican**	0.53437308	**36**
Netherlands	0.65371863	**16**	**Netherlands**	0.68038386	**15**
New Zeland	0.69711854	**8**	**New Zeland**	0.72248087	**8**
Norway	0.6269212	**20**	**Norway**	0.64876148	**19**
Poland	0.56851283	**31**	**Poland**	0.58872909	**31**
Portugal	0.56105527	**35**	**Portugal**	0.57989369	**32**
Republic of Korea	0.59967074	**29**	**Republic of Korea**	0.62715605	**25**
Slovakia	0.61103658	**24**	**Slovakia**	0.62664435	**26**
Slovenia	0.66759431	**12**	**Slovenia**	0.6867323	**13**
Spain	0.62786889	**19**	**Spain**	0.65620163	**16**
Sweden	0.76227971	**1**	**Sweden**	0.78654188	**1**
Switzerland	0.69080569	**9**	**Switzerland**	0.71745185	**10**
Türkiye	0.47184547	**38**	**Türkiye**	0.44330272	**38**
USA	0.60996881	**25**	**USA**	0.63367603	**23**

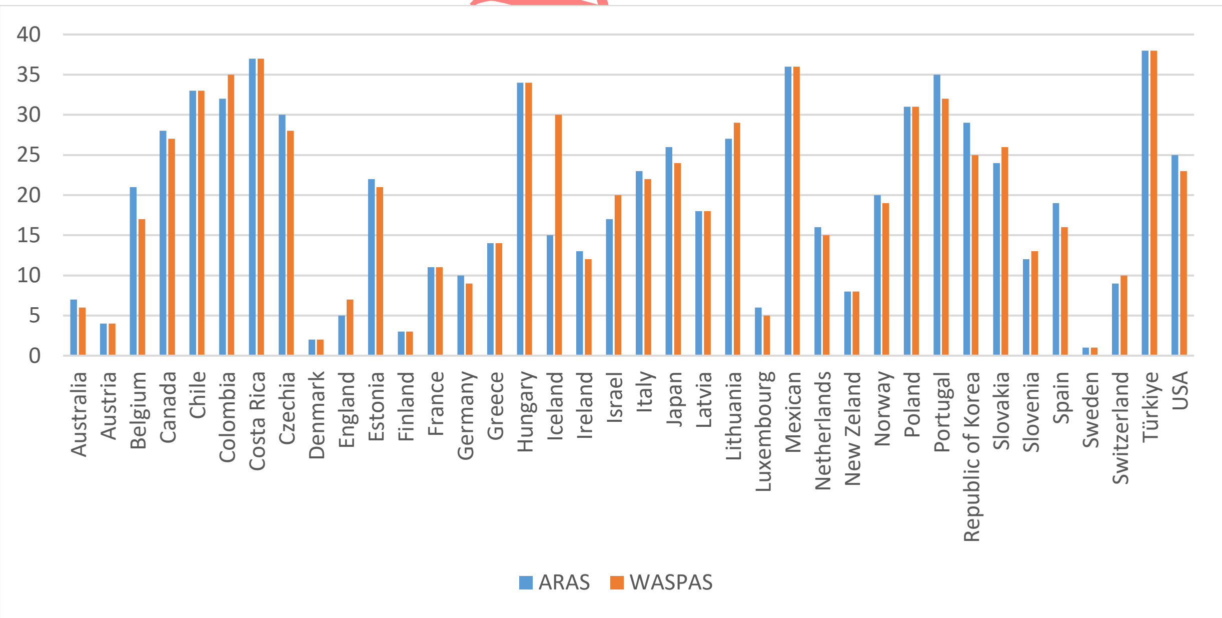

Figure 3. *Ranking of environmental performance levels of OECD countries according to the results obtained from ARAS and WASPAS methods*

Source: The ranking result obtained with the ARAS and WASPAS methods created by the authors.

When Table 6 and Figure 3 are examined, it is seen that the three countries with the highest environmental performance levels according to both methods are Sweden, Denmark and Finland, respectively. The three countries with the lowest environmental performance levels according to both methods are Mexico, Costa Rica and Türkiye.

6. CONCLUSION AND EVALUATION

With the increase in environmental awareness recently, countries are developing various policies to solve their environmental problems. In this regard, countries need to conduct regular performance checks in order to see their situation among other countries and to evaluate the effectiveness of these developed policies.
Based on the explanations, the aim of this study is to determine the environmental performance levels of OECD countries using ARAS and WASPAS methods, which are among the MCDM methods. Before determining performance levels in the study, criterion weights were calculated with the SD method. After calculating the weights of the criteria with the SD method, the criterion with the highest weight has been found to be *the water quality* criterion, while the criterion with the lowest weight has been found to be *the ecosystem services* criterion.

According to the analysis results made with ARAS and WASPAS methods, although some rankings differ, the ranking results are quite similar. According to both methods, the first three countries with the highest environmental performance levels are Sweden, Denmark and Finland, respectively.

In the weighting made with the SD method, the criterion with the highest weight has been found to be *the water quality* criterion. When the current criteria are evaluated, it is seen that Sweden, Denmark and Finland score quite high in *the water quality* criterion. In order to act effectively in preventing disease and promoting health, it is important to know not only about the impact of disease water and hygiene-related factors are on health, but also how the changes which could be done in the management process can improve health [48]. In this regard, it would be beneficial for the countries in the lower ranks to review their own policies by following the policies of countries that are successful in this criterion, such as Sweden, Denmark and Finland.

Duration of exposure to air pollution can cause many negative effects on human health. For this reason, the air quality criterion is of great importance for the environmental performance of countries to be considered at a good level. As a matter of fact, in the weighting made with the SD method, the criterion with the second highest weight has been found to be *the air quality* criterion. When separate evaluations are made based on the existing criteria, it is seen that Sweden, Denmark and Finland receive higher values in this criterion.

Sweden, Denmark and Finland are also countries that rank higher in *biodiversity* criterion. The unconscious plant collection, the constant destruction of forests and the unconscious hunting of animals negatively affect biodiversity. It is very important that countries that rank at the bottom avoid these behaviors and raise awareness on this issue. Additionally, studies should be carried out for creatures in danger of extinction and these creatures should be reintroduced to nature. Training on nature protection should be provided.
Sweden, Denmark and Finland also have higher values in the *climate change mitigation* criterion. Countries with low rankings in terms of environmental performance need to closely follow the successful climate policies of countries such as Sweden, Denmark and Finland.

When the literature is examined, it is seen that there are various studies in which environmental performance is evaluated using MCDM methods. [25, 13, 28] used MCDM methods in their studies and as a result of the analysis, it was determined that the country with the best performance was Sweden, similar to the result of this study.

All countries are required to follow and implement activities aimed at protecting the environment. This is important in terms of preventing environmental problems and improving environmental performance. In order for countries to reach awareness, it would be useful to provide training on environmental awareness. Recently, situations that greatly have an impact on the order of the world, such as biodiversity facing the danger of extinction, the rapid depletion of natural resources and global warming, are issues that should be particularly emphasized in the development and economic growth of countries. In this context, both businesses and country authorities need to develop projects that take environmental factors into account.

This study has some limitations. In the study, SD, ARAS and WASPAS methods from the MCDM methods were used to determine the environmental performance of OECD countries. Countries were analyzed only with 2022 data from EPI in terms of their environmental performance and the number of countries was limited to 38 OECD countries. However, the study was based on 11 main criteria used by EPI and the fishery criterion was not included in the study because it did not include all the data in the relevant report. Based on the explanations, in future studies, the environmental performance of different country groups and regions can be evaluated with the same set of criteria using different MCDM methods, including fuzzy methods, and different weighting methods (e.g., Entropy, Best-Worst Method, FUCOM). How the results will change as a result of this evaluation can be examined. The number of countries subject to analysis can be increased and, in this direction, countries can be grouped according to similar characteristics in terms of their environmental performance by performing cluster analysis. In addition, different studies can be planned by including economic and social criteria. Instead of evaluating environmental performance in a single year, a time series analysis can be performed over a series of years. A study can be planned to evaluate the effectiveness of countries' environmental policies (carbon tax, renewable energy incentives, waste management laws). In addition, a study can be conducted to evaluate the environmental performance of countries in certain sectors (e.g., energy, transportation, agriculture).

CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

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Appendix

ARAS Method Solution Stages

Table A1. *Normalized decision matrix*

Countries	Criteria									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Optimal Value	0.04661	0.03483	0.03025	0.04372	0.03177	0.03088	0.07608	0.04380	0.04027	0.03546
Australia	0.02209	0.03305	0.02635	0.02581	0.02771	0.02865	0.01976	0.02570	0.03612	0.03294
Austria	0.02537	0.02721	0.02865	0.02174	0.03109	0.03001	0.02752	0.02277	0.03756	0.03333
Belgium	0.02426	0.02707	0.02832	0.02960	0.02731	0.02875	0.01602	0.02277	0.01761	0.02418
Canada	0.01423	0.03193	0.02665	0.02062	0.02390	0.02195	0.02929	0.02277	0.02240	0.02390
Chile	0.01806	0.01756	0.02060	0.02037	0.01864	0.02139	0.02791	0.03053	0.02522	0.02549
Colombia	0.01523	0.01596	0.01691	0.03227	0.02422	0.02701	0.03008	0.04380	0.01660	0.00918
Costa Rica	0.02093	0.01865	0.02003	0.03713	0.02109	0.02390	0.02251	0.02705	0.01160	0.00255
Czechia	0.02663	0.01934	0.02314	0.02611	0.03008	0.02906	0.01877	0.02277	0.01990	0.02181
Denmark	0.04661	0.02921	0.02950	0.01972	0.02743	0.02683	0.01612	0.02277	0.04027	0.03546
England	0.04616	0.02852	0.03025	0.02106	0.02514	0.02844	0.02320	0.02277	0.02394	0.03510
Estonia	0.02623	0.02707	0.01873	0.02279	0.02679	0.03001	0.01494	0.02277	0.03288	0.02496
Finland	0.04217	0.03392	0.03025	0.01972	0.02796	0.02481	0.01976	0.02277	0.03335	0.03546
France	0.02497	0.02975	0.02913	0.02373	0.02563	0.03018	0.02113	0.02277	0.02633	0.03120
Germany	0.02381	0.02728	0.02998	0.02196	0.02771	0.03088	0.01759	0.02277	0.03240	0.03439
Greece	0.02563	0.02249	0.02971	0.02874	0.02406	0.02411	0.02762	0.02894	0.02069	0.02897
Hungary	0.02426	0.01386	0.01882	0.02925	0.01743	0.02722	0.02752	0.02277	0.02819	0.01961
Iceland	0.02845	0.03483	0.03025	0.02073	0.02968	0.01989	0.07608	0.02377	0.00984	0.00542
Ireland	0.02431	0.03233	0.02947	0.02410	0.02727	0.02080	0.01710	0.02387	0.02591	0.03085
Israel	0.02008	0.02467	0.02810	0.02164	0.02518	0.01385	0.04148	0.03893	0.01532	0.02897
Italy	0.02431	0.02518	0.02974	0.02446	0.02434	0.02669	0.02565	0.02277	0.02064	0.02085
Japan	0.02078	0.02863	0.02877	0.01972	0.02121	0.02819	0.02634	0.02277	0.01777	0.02652
Latvia	0.02956	0.01854	0.01788	0.02544	0.02530	0.02941	0.01553	0.02397	0.03426	0.03216
Lithuania	0.02376	0.02119	0.01767	0.02375	0.02707	0.02945	0.02153	0.02385	0.03490	0.01854
Luxembourg	0.03400	0.02939	0.02986	0.02073	0.03177	0.02959	0.01779	0.02277	0.02974	0.03475
Mexican	0.01962	0.01241	0.01600	0.04372	0.01747	0.02435	0.03214	0.02528	0.02692	0.00894
Netherlands	0.02749	0.02786	0.03025	0.02095	0.02659	0.02795	0.02398	0.02277	0.01559	0.03546
New Zeland	0.02038	0.03381	0.02432	0.02643	0.02446	0.02673	0.02644	0.02997	0.03452	0.02833
Norway	0.02214	0.03352	0.03025	0.02120	0.02840	0.02484	0.03027	0.02277	0.01357	0.02280
Poland	0.01957	0.01466	0.02172	0.03057	0.02559	0.03046	0.01740	0.02287	0.02272	0.02181
Portugal	0.01897	0.02834	0.02526	0.03052	0.02510	0.02460	0.00845	0.02277	0.01250	0.02099
Republic of Korea	0.01559	0.02282	0.02747	0.02230	0.02892	0.02128	0.01740	0.02702	0.02346	0.02723
Slovakia	0.02699	0.01847	0.02175	0.02882	0.02498	0.02886	0.01956	0.02277	0.03617	0.01585
Slovenia	0.03173	0.01999	0.02260	0.02261	0.02679	0.02948	0.03352	0.02277	0.02926	0.03269
Spain	0.02083	0.02685	0.02931	0.02797	0.02466	0.02994	0.01317	0.02277	0.01692	0.03230
Sweden	0.03803	0.03410	0.02983	0.02035	0.02844	0.02401	0.02880	0.02277	0.03937	0.03546
Switzerland	0.03052	0.03059	0.03025	0.02097	0.03069	0.02181	0.03017	0.02277	0.02186	0.03439
Türkiye	0.01085	0.01618	0.01594	0.03243	0.01631	0.00262	0.02162	0.03685	0.02080	0.01081
USA	0.01877	0.02794	0.02605	0.02625	0.02181	0.02114	0.01976	0.02277	0.03266	0.02088

Table A2. *Weighted normalized decision matrix*

Countries	Criteria									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Optimal Value	0.00413	0.00397	0.00410	0.00451	0.00304	0.00233	0.00483	0.00461	0.00442	0.00387
Australia	0.00196	0.00377	0.00357	0.00266	0.00265	0.00216	0.00126	0.00270	0.00397	0.00359
Austria	0.00225	0.00310	0.00388	0.00224	0.00298	0.00226	0.00175	0.00240	0.00412	0.00363
Belgium	0.00215	0.00308	0.00384	0.00305	0.00262	0.00217	0.00102	0.00240	0.00193	0.00264

Canada	0.00126	0.00364	0.00361	0.00213	0.00229	0.00166	0.00186	0.00240	0.00246	0.00261
Chile	0.00160	0.00200	0.00279	0.00210	0.00178	0.00161	0.00177	0.00321	0.00277	0.00278
Colombia	0.00135	0.00182	0.00229	0.00333	0.00232	0.00204	0.00191	0.00461	0.00182	0.00100
Costa Rica	0.00186	0.00212	0.00271	0.00383	0.00202	0.00180	0.00143	0.00285	0.00127	0.00028
Czechia	0.00236	0.00220	0.00314	0.00269	0.00288	0.00219	0.00119	0.00240	0.00218	0.00238
Denmark	0.00413	0.00333	0.00400	0.00203	0.00263	0.00202	0.00102	0.00240	0.00442	0.00387
England	0.00409	0.00325	0.00410	0.00217	0.00241	0.00214	0.00147	0.00240	0.00263	0.00383
Estonia	0.00232	0.00308	0.00254	0.00235	0.00257	0.00226	0.00095	0.00240	0.00361	0.00272
Finland	0.00374	0.00386	0.00410	0.00203	0.00268	0.00187	0.00126	0.00240	0.00366	0.00387
France	0.00221	0.00339	0.00395	0.00245	0.00245	0.00228	0.00134	0.00240	0.00289	0.00340
Germany	0.00211	0.00311	0.00406	0.00226	0.00265	0.00233	0.00112	0.00240	0.00356	0.00375
Greece	0.00227	0.00256	0.00403	0.00296	0.00230	0.00182	0.00175	0.00304	0.00227	0.00316
Hungary	0.00215	0.00158	0.00255	0.00302	0.00167	0.00205	0.00175	0.00240	0.00310	0.00214
Iceland	0.00252	0.00397	0.00410	0.00214	0.00284	0.00150	0.00483	0.00250	0.00108	0.00059
Ireland	0.00216	0.00368	0.00399	0.00249	0.00261	0.00157	0.00109	0.00251	0.00284	0.00336
Israel	0.00178	0.00281	0.00381	0.00223	0.00241	0.00104	0.00264	0.00410	0.00168	0.00316
Italy	0.00216	0.00287	0.00403	0.00252	0.00233	0.00201	0.00163	0.00240	0.00227	0.00227
Japan	0.00184	0.00326	0.00390	0.00203	0.00203	0.00213	0.00167	0.00240	0.00195	0.00289
Latvia	0.00262	0.00211	0.00242	0.00262	0.00242	0.00222	0.00099	0.00252	0.00376	0.00351
Lithuania	0.00211	0.00241	0.00240	0.00245	0.00259	0.00222	0.00137	0.00251	0.00383	0.00202
Luxembourg	0.00301	0.00335	0.00405	0.00214	0.00304	0.00223	0.00113	0.00240	0.00326	0.00379
Mexican	0.00174	0.00141	0.00217	0.00451	0.00167	0.00184	0.00204	0.00266	0.00296	0.00097
Netherlands	0.00244	0.00317	0.00410	0.00216	0.00255	0.00211	0.00152	0.00240	0.00171	0.00387
New Zeland	0.00181	0.00385	0.00330	0.00273	0.00234	0.00202	0.00168	0.00315	0.00379	0.00309
Norway	0.00196	0.00382	0.00410	0.00219	0.00272	0.00187	0.00192	0.00240	0.00149	0.00249
Poland	0.00173	0.00167	0.00294	0.00315	0.00245	0.00230	0.00111	0.00241	0.00249	0.00238
Portugal	0.00168	0.00323	0.00342	0.00315	0.00240	0.00186	0.00054	0.00240	0.00137	0.00229
Republic of Korea	0.00138	0.00260	0.00372	0.00230	0.00277	0.00161	0.00111	0.00284	0.00258	0.00297
Slovakia	0.00239	0.00210	0.00295	0.00297	0.00239	0.00218	0.00124	0.00240	0.00397	0.00173
Slovenia	0.00281	0.00228	0.00306	0.00233	0.00257	0.00222	0.00213	0.00240	0.00321	0.00356
Spain	0.00185	0.00306	0.00397	0.00288	0.00236	0.00226	0.00084	0.00240	0.00186	0.00352
Sweden	0.00337	0.00389	0.00404	0.00210	0.00272	0.00181	0.00183	0.00240	0.00432	0.00387
Switzerland	0.00270	0.00348	0.00410	0.00216	0.00294	0.00164	0.00192	0.00240	0.00240	0.00375
Türkiye	0.00096	0.00184	0.00216	0.00335	0.00156	0.00020	0.00137	0.00388	0.00228	0.00118
USA	0.00166	0.00318	0.00353	0.00271	0.00209	0.00159	0.00126	0.00240	0.00359	0.00228

Table A3. *Optimality values*

	S_i	K_i	Rank
Optimal Value	0.03980889		
Australia	0.02828824	0.71060105	**7**
Austria	0.02861635	0.7188432	**4**
Belgium	0.02489353	0.62532575	**21**
Canada	0.02390336	0.60045283	**28**
Chile	0.02242568	0.56333331	**33**
Colombia	0.02248838	0.56490848	**32**
Costa Rica	0.02017439	0.50678095	**37**
Czechia	0.02361814	0.59328813	**30**
Denmark	0.02984811	0.74978498	**2**
England	0.02849071	0.71568717	**5**
Estonia	0.02480254	0.62304014	**22**
Finland	0.0294637	0.74012857	**3**
France	0.0267605	0.67222418	**11**
Germany	0.02735033	0.68704058	**10**
Greece	0.02617741	0.65757701	**14**
Hungary	0.02239728	0.56262011	**34**
Iceland	0.02607825	0.65508605	**15**
Ireland	0.02630381	0.66075218	**13**
Israel	0.02565996	0.64457859	**17**
Italy	0.02448704	0.6151147	**23**
Japan	0.0241058	0.60553819	**26**
Latvia	0.02519752	0.63296207	**18**
Lithuania	0.02390798	0.6005688	**27**
Luxembourg	0.02840083	0.71342923	**6**
Mexican	0.02197261	0.55195231	**36**
Netherlands	0.02602381	0.65371863	**16**
New Zeland	0.02775152	0.69711854	**8**
Norway	0.02495704	0.6269212	**20**
Poland	0.02263187	0.56851283	**31**
Portugal	0.02233499	0.56105527	**35**

Republic of Korea	0.02387223	0.59967074	**29**
Slovakia	0.02432469	0.61103658	**24**
Slovenia	0.02657619	0.66759431	**12**
Spain	0.02499477	0.62786889	**19**
Sweden	0.03034551	0.76227971	**1**
Switzerland	0.02750021	0.69080569	**9**
Türkiye	0.01878365	0.47184547	**38**
USA	0.02428218	0.60996881	**25**

WASPAS Method Solution Stages

Table A4. *Normalized decision matrix*

Countries	**Criteria**									
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
Australia	0.47403	0.94896	0.87100	0.59031	0.87231	0.92768	0.25969	0.58691	0.89696	0.92900
Austria	0.54437	0.78125	0.94700	0.49724	0.97851	0.97175	0.36176	0.52000	0.93263	0.94000
Belgium	0.52056	0.77708	0.93600	0.67718	0.85967	0.93107	0.21059	0.52000	0.43725	0.68200
Canada	0.30519	0.91667	0.88100	0.47176	0.75221	0.71073	0.38501	0.52000	0.55614	0.67400
Chile	0.38745	0.50417	0.68100	0.46591	0.58660	0.69266	0.36693	0.69705	0.62616	0.71900
Colombia	0.32684	0.45833	0.55900	0.73813	0.76233	0.87458	0.39535	1.00000	0.41215	0.25900
Costa Rica	0.44913	0.53542	0.66200	0.84934	0.66372	0.77401	0.29587	0.61758	0.28798	0.07200
Czechia	0.57143	0.55521	0.76500	0.59735	0.94690	0.94124	0.24677	0.52000	0.49406	0.61500
Denmark	1.00000	0.83854	0.97500	0.45100	0.86346	0.86893	0.21189	0.52000	1.00000	1.00000
England	0.99026	0.81875	1.00000	0.48184	0.79140	0.92090	0.30491	0.52000	0.59445	0.99000
Estonia	0.56277	0.77708	0.61900	0.52139	0.84324	0.97175	0.19638	0.52000	0.81638	0.70400
Finland	0.90476	0.97396	1.00000	0.45100	0.87990	0.80339	0.25969	0.52000	0.82827	1.00000
France	0.53571	0.85417	0.96300	0.54272	0.80657	0.97740	0.27778	0.52000	0.65390	0.88000
Germany	0.51082	0.78333	0.99100	0.50223	0.87231	1.00000	0.23127	0.52000	0.80449	0.97000
Greece	0.54978	0.64583	0.98200	0.65743	0.75727	0.78079	0.36305	0.66074	0.51387	0.81700
Hungary	0.52056	0.39792	0.62200	0.66914	0.54867	0.88136	0.36176	0.52000	0.70013	0.55300
Iceland	0.61039	1.00000	1.00000	0.47424	0.93426	0.64407	1.00000	0.54280	0.24439	0.15300
Ireland	0.52165	0.92813	0.97400	0.55134	0.85841	0.67345	0.22481	0.54507	0.64333	0.87000
Israel	0.43074	0.70833	0.92900	0.49506	0.79267	0.44859	0.54522	0.88889	0.38045	0.81700
Italy	0.52165	0.72292	0.98300	0.55955	0.76612	0.86441	0.33721	0.52000	0.51255	0.58800
Japan	0.44589	0.82188	0.95100	0.45100	0.66751	0.91299	0.34625	0.52000	0.44122	0.74800
Latvia	0.63420	0.53229	0.59100	0.58194	0.79646	0.95254	0.20413	0.54737	0.85073	0.90700
Lithuania	0.50974	0.60833	0.58400	0.54337	0.85209	0.95367	0.28295	0.54450	0.86658	0.52300
Luxembourg	0.72944	0.84375	0.98700	0.47424	1.00000	0.95819	0.23385	0.52000	0.73844	0.98000
Mexican	0.42100	0.35625	0.52900	1.00000	0.54994	0.78870	0.42248	0.57714	0.66843	0.25200
Netherlands	0.58983	0.80000	1.00000	0.47928	0.83692	0.90508	0.31525	0.52000	0.38705	1.00000
New Zeland	0.43723	0.97083	0.80400	0.60456	0.76991	0.86554	0.34755	0.68421	0.85733	0.79900
Norway	0.47511	0.96250	1.00000	0.48495	0.89381	0.80452	0.39793	0.52000	0.33686	0.64300
Poland	0.41991	0.42083	0.71800	0.69922	0.80531	0.98644	0.22868	0.52209	0.56407	0.61500
Portugal	0.40693	0.81354	0.83500	0.69814	0.79014	0.79661	0.11111	0.52000	0.31044	0.59200
Republic of Korea	0.33442	0.65521	0.90800	0.51018	0.91024	0.68927	0.22868	0.61684	0.58256	0.76800
Slovakia	0.57900	0.53021	0.71900	0.65936	0.78635	0.93446	0.25711	0.52000	0.89828	0.44700
Slovenia	0.68074	0.57396	0.74700	0.51720	0.84324	0.95480	0.44057	0.52000	0.72655	0.92200
Spain	0.44697	0.77083	0.96900	0.63972	0.77623	0.96949	0.17313	0.52000	0.42008	0.91100
Sweden	0.81602	0.97917	0.98600	0.46543	0.89507	0.77740	0.37855	0.52000	0.97754	1.00000
Switzerland	0.65476	0.87813	1.00000	0.47979	0.96587	0.70621	0.39664	0.52000	0.54293	0.97000
Türkiye	0.23268	0.46458	0.52700	0.74178	0.51327	0.08475	0.28424	0.84142	0.51651	0.30500
USA	0.40260	0.80208	0.86100	0.60053	0.68647	0.68475	0.25969	0.52000	0.81110	0.58900

Table A5. *Total relative importance values based on Weighted Sum Method (WSM)*

Countries	**Criteria**										
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	$Q_i^{(1)}$
Australia	0.04201	0.10810	0.11808	0.06090	0.08354	0.06996	0.01650	0.06175	0.09847	0.10127	**0.76059**
Austria	0.04825	0.08900	0.12838	0.05130	0.09371	0.07329	0.02298	0.05471	0.10239	0.10247	**0.76647**
Belgium	0.04614	0.08853	0.12689	0.06986	0.08233	0.07022	0.01338	0.05471	0.04800	0.07434	**0.67439**
Canada	0.02705	0.10443	0.11943	0.04867	0.07204	0.05360	0.02446	0.05471	0.06106	0.07347	**0.63891**
Chile	0.03434	0.05743	0.09232	0.04806	0.05618	0.05224	0.02331	0.07334	0.06874	0.07838	**0.58434**
Colombia	0.02897	0.05221	0.07578	0.07615	0.07301	0.06596	0.02512	0.10521	0.04525	0.02823	**0.57588**
Costa Rica	0.03981	0.06099	0.08974	0.08762	0.06356	0.05837	0.01880	0.06497	0.03162	0.00785	**0.52334**
Czechia	0.05065	0.06325	0.10371	0.06162	0.09068	0.07099	0.01568	0.05471	0.05424	0.06704	**0.63256**
Denmark	0.08863	0.09553	0.13218	0.04652	0.08269	0.06553	0.01346	0.05471	0.10979	0.10901	**0.79805**
England	0.08777	0.09327	0.13556	0.04971	0.07579	0.06945	0.01937	0.05471	0.06526	0.10792	**0.75882**
Estonia	0.04988	0.08853	0.08391	0.05379	0.08076	0.07329	0.01248	0.05471	0.08963	0.07674	**0.66370**
Finland	0.08019	0.11095	0.13556	0.04652	0.08427	0.06059	0.01650	0.05471	0.09093	0.10901	**0.78924**
France	0.04748	0.09731	0.13055	0.05599	0.07724	0.07371	0.01765	0.05471	0.07179	0.09593	**0.72235**

Germany	0.04528	0.08924	0.13434	0.05181	0.08354	0.07542	0.01469	0.05471	0.08832	0.10574	**0.74309**
Greece	0.04873	0.07357	0.13312	0.06782	0.07252	0.05889	0.02307	0.06952	0.05642	0.08906	**0.69271**
Hungary	0.04614	0.04533	0.08432	0.06903	0.05255	0.06647	0.02298	0.05471	0.07687	0.06028	**0.57867**
Iceland	0.05410	0.11392	0.13556	0.04892	0.08947	0.04857	0.06353	0.05711	0.02683	0.01668	**0.65470**
Ireland	0.04623	0.10573	0.13204	0.05688	0.08221	0.05079	0.01428	0.05735	0.07063	0.09484	**0.71098**
Israel	0.03818	0.08069	0.12594	0.05107	0.07591	0.03383	0.03464	0.09352	0.04177	0.08906	**0.66461**
Italy	0.04623	0.08235	0.13326	0.05772	0.07337	0.06519	0.02142	0.05471	0.05627	0.06410	**0.65463**
Japan	0.03952	0.09363	0.12892	0.04652	0.06393	0.06886	0.02200	0.05471	0.04844	0.08154	**0.64806**
Latvia	0.05621	0.06064	0.08012	0.06003	0.07628	0.07184	0.01297	0.05759	0.09340	0.09887	**0.66794**
Lithuania	0.04518	0.06930	0.07917	0.05605	0.08160	0.07192	0.01798	0.05729	0.09514	0.05701	**0.63064**
Luxembourg	0.06465	0.09612	0.13380	0.04892	0.09577	0.07227	0.01486	0.05471	0.08107	0.10683	**0.76899**
Mexican	0.03731	0.04058	0.07171	0.10316	0.05267	0.05948	0.02684	0.06072	0.07338	0.02747	**0.55334**
Netherlands	0.05228	0.09114	0.13556	0.04944	0.08015	0.06826	0.02003	0.05471	0.04249	0.10901	**0.70307**
New Zeland	0.03875	0.11060	0.10899	0.06237	0.07373	0.06528	0.02208	0.07199	0.09412	0.08710	**0.73501**
Norway	0.04211	0.10965	0.13556	0.05003	0.08560	0.06068	0.02528	0.05471	0.03698	0.07009	**0.67069**
Poland	0.03722	0.04794	0.09734	0.07213	0.07712	0.07440	0.01453	0.05493	0.06193	0.06704	**0.60457**
Portugal	0.03607	0.09268	0.11320	0.07202	0.07567	0.06008	0.00706	0.05471	0.03408	0.06453	**0.61009**
Republic of Korea	0.02964	0.07464	0.12309	0.05263	0.08717	0.05198	0.01453	0.06490	0.06396	0.08372	**0.64626**
Slovakia	0.05132	0.06040	0.09747	0.06802	0.07531	0.07048	0.01634	0.05471	0.09862	0.04873	**0.64138**
Slovenia	0.06034	0.06539	0.10127	0.05335	0.08076	0.07201	0.02799	0.05471	0.07977	0.10050	**0.69608**
Spain	0.03962	0.08781	0.13136	0.06599	0.07434	0.07312	0.01100	0.05471	0.04612	0.09930	**0.68337**
Sweden	0.07233	0.11155	0.13367	0.04801	0.08572	0.05863	0.02405	0.05471	0.10732	0.10901	**0.80499**
Switzerland	0.05803	0.10004	0.13556	0.04949	0.09250	0.05326	0.02520	0.05471	0.05961	0.10574	**0.73414**
Türkiye	0.02062	0.05293	0.07144	0.07652	0.04916	0.00639	0.01806	0.08853	0.05671	0.03325	**0.47360**
USA	0.03568	0.09137	0.11672	0.06195	0.06574	0.05164	0.01650	0.05471	0.08905	0.06420	**0.64757**

Table A6. *Total relative importance values based on Weighted Product Method (WPM)*

Countries	**Criteria**												
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	$Q_i^{(2)}$	Q_i	**Rank**
Australia	0.9360	0.9940	0.9815	0.9471	0.9870	0.9944	0.9179	0.9455	0.9881	0.9920	0.7220	0.7413	**6**
Austria	0.9475	0.9723	0.9926	0.9305	0.9979	0.9978	0.9374	0.9335	0.9924	0.9933	0.7309	0.7487	**4**
Belgium	0.9438	0.9717	0.9911	0.9606	0.9856	0.9946	0.9058	0.9335	0.9132	0.9591	0.6338	0.6541	**17**
Canada	0.9002	0.9901	0.9830	0.9254	0.9731	0.9746	0.9412	0.9335	0.9376	0.9579	0.6067	0.6228	**27**
Chile	0.9194	0.9249	0.9493	0.9242	0.9502	0.9727	0.9383	0.9627	0.9499	0.9647	0.5708	0.5776	**33**
Colombia	0.9056	0.9150	0.9242	0.9692	0.9743	0.9899	0.9427	1.0000	0.9073	0.8631	0.5285	0.5522	**35**
Costa Rica	0.9315	0.9313	0.9456	0.9833	0.9615	0.9809	0.9255	0.9506	0.8723	0.7507	0.4382	0.4808	**37**
Czechia	0.9516	0.9352	0.9643	0.9482	0.9948	0.9954	0.9149	0.9335	0.9255	0.9484	0.6041	0.6183	**28**
Denmark	1.0000	0.9801	0.9966	0.9211	0.9860	0.9895	0.9061	0.9335	1.0000	1.0000	0.7425	0.7703	**2**
England	0.9991	0.9775	1.0000	0.9274	0.9778	0.9938	0.9273	0.9335	0.9445	0.9989	0.7189	0.7389	**7**
Estonia	0.9503	0.9717	0.9370	0.9350	0.9838	0.9978	0.9018	0.9335	0.9780	0.9625	0.6293	0.6465	**21**
Finland	0.9912	0.9970	1.0000	0.9211	0.9878	0.9836	0.9179	0.9335	0.9795	1.0000	0.7424	0.7658	**3**
France	0.9462	0.9822	0.9949	0.9389	0.9796	0.9983	0.9218	0.9335	0.9544	0.9862	0.6876	0.7050	**11**
Germany	0.9422	0.9726	0.9988	0.9314	0.9870	1.0000	0.9112	0.9335	0.9764	0.9967	0.6965	0.7198	**9**
Greece	0.9484	0.9514	0.9975	0.9577	0.9737	0.9815	0.9377	0.9573	0.9295	0.9782	0.6724	0.6825	**14**
Hungary	0.9438	0.9003	0.9377	0.9594	0.9441	0.9905	0.9374	0.9335	0.9616	0.9375	0.5640	0.5713	**34**
Iceland	0.9572	1.0000	1.0000	0.9259	0.9935	0.9674	1.0000	0.9377	0.8567	0.8149	0.5577	0.6062	**30**
Ireland	0.9440	0.9915	0.9964	0.9404	0.9855	0.9706	0.9095	0.9382	0.9527	0.9849	0.6717	0.6914	**12**
Israel	0.9281	0.9615	0.9901	0.9300	0.9780	0.9413	0.9622	0.9877	0.8993	0.9782	0.6324	0.6485	**20**
Italy	0.9440	0.9637	0.9977	0.9419	0.9748	0.9891	0.9333	0.9335	0.9293	0.9438	0.6297	0.6422	**22**
Japan	0.9309	0.9779	0.9932	0.9211	0.9620	0.9932	0.9348	0.9335	0.9141	0.9688	0.6150	0.6315	**24**
Latvia	0.9604	0.9307	0.9312	0.9457	0.9784	0.9963	0.9040	0.9386	0.9824	0.9894	0.6328	0.6504	**18**
Lithuania	0.9420	0.9450	0.9297	0.9390	0.9848	0.9964	0.9229	0.9380	0.9844	0.9318	0.6055	0.6181	**29**
Luxembourg	0.9724	0.9808	0.9982	0.9259	1.0000	0.9968	0.9118	0.9335	0.9673	0.9978	0.7219	0.7454	**5**
Mexican	0.9262	0.8891	0.9173	1.0000	0.9443	0.9823	0.9467	0.9438	0.9567	0.8605	0.5154	0.5344	**36**
Netherlands	0.9543	0.9749	1.0000	0.9269	0.9831	0.9925	0.9293	0.9335	0.9010	1.0000	0.6577	0.6804	**15**
New Zeland	0.9293	0.9966	0.9709	0.9494	0.9753	0.9892	0.9351	0.9609	0.9832	0.9758	0.7100	0.7225	**8**
Norway	0.9362	0.9957	1.0000	0.9281	0.9893	0.9837	0.9431	0.9335	0.8874	0.9530	0.6268	0.6488	**19**
Poland	0.9260	0.9061	0.9561	0.9638	0.9795	0.9990	0.9105	0.9339	0.9391	0.9484	0.5729	0.5887	**31**
Portugal	0.9234	0.9768	0.9759	0.9636	0.9777	0.9830	0.8697	0.9335	0.8795	0.9445	0.5497	0.5799	**32**
Republic of Korea	0.9075	0.9530	0.9870	0.9329	0.9910	0.9723	0.9105	0.9504	0.9424	0.9716	0.6081	0.6272	**25**
Slovakia	0.9527	0.9303	0.9563	0.9579	0.9772	0.9949	0.9173	0.9335	0.9883	0.9160	0.6119	0.6266	**26**
Slovenia	0.9665	0.9387	0.9612	0.9342	0.9838	0.9965	0.9493	0.9335	0.9655	0.9912	0.6774	0.6867	**13**
Spain	0.9311	0.9708	0.9957	0.9550	0.9760	0.9977	0.8946	0.9335	0.9092	0.9899	0.6290	0.6562	**16**
Sweden	0.9821	0.9976	0.9981	0.9241	0.9894	0.9812	0.9401	0.9335	0.9975	1.0000	0.7681	0.7865	**1**
Switzerland	0.9632	0.9853	1.0000	0.9270	0.9967	0.9741	0.9429	0.9335	0.9351	0.9967	0.7008	0.7175	**10**
Türkiye	0.8788	0.9164	0.9168	0.9697	0.9381	0.8302	0.9232	0.9820	0.9300	0.8786	0.4130	0.4433	**38**
USA	0.9225	0.9752	0.9799	0.9488	0.9646	0.9718	0.9179	0.9335	0.9773	0.9439	0.6198	0.6337	**23**

Table A7. *λ Effect of WASPAS method performance on ranking*

	λ=0	**λ=0,1**	**λ=0,2**	**λ=0,3**	**λ=0,4**	**λ=0,5**	**λ=0,6**	**λ=0,7**	**λ=0,8**	**λ=0,9**	**λ=1**	**Rank**
Australia	0.72205	0.72590	0.72975	0.73361	0.73746	0.74132	0.74517	0.74902	0.75288	0.75673	0.76059	**6**
Austria	0.73087	0.73443	0.73799	0.74155	0.74511	0.74867	0.75223	0.75579	0.75935	0.76291	0.76647	**4**
Belgium	0.63384	0.63790	0.64195	0.64601	0.65006	0.65412	0.65817	0.66223	0.66628	0.67034	0.67439	**17**
Canada	0.60673	0.60995	0.61317	0.61639	0.61961	0.62282	0.62604	0.62926	0.63248	0.63570	0.63891	**27**
Chile	0.57079	0.57214	0.57350	0.57485	0.57621	0.57757	0.57892	0.58028	0.58163	0.58299	0.58434	**33**
Colombia	0.52846	0.53320	0.53795	0.54269	0.54743	0.55217	0.55691	0.56166	0.56640	0.57114	0.57588	**35**
Costa Rica	0.43823	0.44674	0.45525	0.46376	0.47227	0.48079	0.48930	0.49781	0.50632	0.51483	0.52334	**37**

Czechia	0.60411	0.60696	0.60980	0.61265	0.61549	0.61834	0.62118	0.62403	0.62687	0.62972	0.63256	**28**
Denmark	0.74254	0.74809	0.75364	0.75919	0.76474	0.77029	0.77585	0.78140	0.78695	0.79250	0.79805	**2**
England	0.71889	0.72288	0.72687	0.73087	0.73486	0.73885	0.74285	0.74684	0.75083	0.75482	0.75882	**7**
Estonia	0.62931	0.63275	0.63619	0.63963	0.64307	0.64651	0.64995	0.65339	0.65682	0.66026	0.66370	**21**
Finland	0.74235	0.74704	0.75173	0.75642	0.76111	0.76580	0.77048	0.77517	0.77986	0.78455	0.78924	**3**
France	0.68763	0.69110	0.69458	0.69805	0.70152	0.70499	0.70847	0.71194	0.71541	0.71888	0.72235	**11**
Germany	0.69646	0.70113	0.70579	0.71045	0.71511	0.71977	0.72444	0.72910	0.73376	0.73842	0.74309	**9**
Greece	0.67237	0.67440	0.67644	0.67847	0.68051	0.68254	0.68457	0.68661	0.68864	0.69068	0.69271	**14**
Hungary	0.56396	0.56543	0.56690	0.56837	0.56984	0.57131	0.57279	0.57426	0.57573	0.57720	0.57867	**34**
Iceland	0.55765	0.56736	0.57706	0.58677	0.59647	0.60618	0.61588	0.62559	0.63529	0.64500	0.65470	**30**
Ireland	0.67174	0.67566	0.67959	0.68351	0.68743	0.69136	0.69528	0.69920	0.70313	0.70705	0.71098	**12**
Israel	0.63241	0.63563	0.63885	0.64207	0.64529	0.64851	0.65173	0.65495	0.65817	0.66139	0.66461	**20**
Italy	0.62971	0.63220	0.63470	0.63719	0.63968	0.64217	0.64467	0.64716	0.64965	0.65214	0.65463	**22**
Japan	0.61500	0.61831	0.62161	0.62492	0.62823	0.63153	0.63484	0.63814	0.64145	0.64476	0.64806	**24**
Latvia	0.63283	0.63634	0.63985	0.64336	0.64687	0.65039	0.65390	0.65741	0.66092	0.66443	0.66794	**18**
Lithuania	0.60554	0.60805	0.61056	0.61307	0.61558	0.61809	0.62060	0.62311	0.62562	0.62813	0.63064	**29**
Luxembourg	0.72189	0.72660	0.73131	0.73602	0.74073	0.74544	0.75015	0.75486	0.75957	0.76428	0.76899	**5**
Mexican	0.51541	0.51920	0.52300	0.52679	0.53058	0.53437	0.53817	0.54196	0.54575	0.54954	0.55334	**36**
Netherlands	0.65770	0.66224	0.66677	0.67131	0.67585	0.68038	0.68492	0.68946	0.69399	0.69853	0.70307	**15**
New Zeland	0.70996	0.71246	0.71497	0.71747	0.71998	0.72248	0.72499	0.72749	0.73000	0.73250	0.73501	**8**
Norway	0.62684	0.63122	0.63561	0.63999	0.64438	0.64876	0.65315	0.65753	0.66192	0.66630	0.67069	**19**
Poland	0.57289	0.57606	0.57923	0.58239	0.58556	0.58873	0.59190	0.59507	0.59823	0.60140	0.60457	**31**
Portugal	0.54969	0.55573	0.56177	0.56781	0.57385	0.57989	0.58593	0.59197	0.59801	0.60405	0.61009	**32**
Republic of Korea	0.60805	0.61187	0.61569	0.61951	0.62334	0.62716	0.63098	0.63480	0.63862	0.64244	0.64626	**25**
Slovakia	0.61191	0.61485	0.61780	0.62075	0.62370	0.62664	0.62959	0.63254	0.63549	0.63843	0.64138	**26**
Slovenia	0.67739	0.67926	0.68113	0.68299	0.68486	0.68673	0.68860	0.69047	0.69234	0.69421	0.69608	**13**
Spain	0.62903	0.63447	0.63990	0.64533	0.65077	0.65620	0.66164	0.66707	0.67250	0.67794	0.68337	**16**
Sweden	0.76809	0.77178	0.77547	0.77916	0.78285	0.78654	0.79023	0.79392	0.79761	0.80130	0.80499	**1**
Switzerland	0.70076	0.70410	0.70744	0.71078	0.71411	0.71745	0.72079	0.72413	0.72747	0.73080	0.73414	**10**
Türkiye	0.4130	0.41907	0.42513	0.43119	0.43724	0.44330	0.44936	0.45542	0.46148	0.46754	0.47360	**38**
USA	0.61978	0.62256	0.62534	0.62812	0.63090	0.63368	0.63646	0.63923	0.64201	0.64479	0.64757	**23**