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The MEREC-AROMAN method for determining sustainable competitiveness levels: A case study for Turkey

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ABSTRACT

Sustainable competitiveness represents a multifaceted phenomenon encompassing economic, environmental, and social dimensions. Macro-level competitiveness strategies are formulated based on the diverse capitals possessed by individual countries, thereby giving rise to variations in the sustainable competitiveness strategies of each country. This research introduces a novel hybrid method called the method based on the removal effects of criteria (MEREC)–alternative ranking order method accounting for two-step normalization (AROMAN) for determining sustainable competitiveness levels. This study aims to assess Turkey's sustainable competitiveness position vis-à-vis its border neighbors. Natural capital, resource efficiency and intensity, social capital, intellectual capital and innovation, economic sustainability, and governance efficiency are the Global Sustainable Competitiveness Index (GSCI) indicators. The GSCI indicators are employed as criteria for determining the sustainable competitiveness scores of countries. The findings show that the "resource efficiency and intensity" criterion has the highest level of significance. The sustainable competitiveness level of Turkey to its neighboring countries is elucidated based on the results. Recommendations are formulated for the development of strategies aimed at determining Turkey's position in the race for sustainable competitiveness. The introduced MEREC-AROMAN can be utilized to provide rules of thumb for other countries to improve their sustainable competitiveness. This research offers decision support for the formulation of countries' sustainable competitiveness strategies and policies, fostering awareness in the planning and establishment of regional collaborations among nations.

1. Introduction

Competitiveness, a multifaceted and dynamic construct, has been characterized as an intricate and contextually contingent concept, subject to evolution and contextual variations [1,2]. The complex terrain of competitiveness encompasses diverse research inquiries across different levels, encompassing the firm, industry, and national domains [3].

When examining the role and impact of functional strategies, particularly within the production and operations management domains, the term "firm-level competitiveness" has been employed interchangeably with "business performance" in the realm of strategic management [4,5]. The concept of competitive advantage, which is one of the cornerstones in the strategic management field hinges upon the notion of competitiveness at the firm level [6]. When the concept of competitiveness is considered within this framework, the attainment of an industrial dominance position vis-à-vis competitors is referred to as

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competitive advantage, reflecting the concepts of asymmetry, differentiation, comparison, and institutional competition [7]. Competitiveness at the firm level denotes a company's capacity to produce goods and services more effectively and/or efficiently than its rivals [8]. By relying on certain resources and capabilities a company can attain a strong competitive performance. However, at the industry level competitiveness pertains to the extent to which an industry satisfies consumer needs through a distinct amalgamation of products, services, pricing, quality, and innovation, while also addressing the requirements of stakeholders, such as employee safety [9].

At the industry level, competitiveness implies that several clusters of companies are using and activating competitive characteristics. However, in a competitive industry, there may be both many competitive firms and some underperforming ones [8]. Considering these clusters, an industry's competitiveness can be gauged by its capacity to generate superior returns on investment in comparison to similar industries in alternative free-trade regions or nations [10].

Competitiveness at the national level is denoted as the extent to which a country, operating within conditions of equitable and unimpeded market dynamics, is capable of generating goods and services that meet international market standards, while simultaneously safeguarding and augmenting the actual income of its populace over time [11]. At this level, competitiveness is not limited to a market perspective. In essence, it represents the amalgamation of institutions and economic policies that foster sustained, robust economic growth rates in the medium term [8]. While these concepts are not synonymous, they share a fundamental essence in establishing an enabling environment for a country's advancement [12].

Porter & Sölvell [13] expound upon the notion of sustainable competitiveness, wherein a sustainable competitive advantage is achieved through a market strategy centered around the creation of enduring value, unique customer importance, and a distinctive amalgamation of resources and capabilities that are impervious to replication by competitors. Consequently, the categories of competitiveness, stability, continuity, and expansion are regarded as interconnected. SolAbility, a sustainability consultancy established as a Swiss-Korean venture, similarly posits that sustainable competitiveness refers to a country's capacity to fulfill the present generations' needs and fundamental requisites while concurrently preserving or augmenting national and individual wealth in the future, all while conserving natural and social capital [14].

Various factors influence the economic development of nations, with sustainable competitiveness constituting one of these variables [15]. In the realm of macroeconomics, competitiveness is explicated as the ability to achieve economic growth in the context of international market conditions, relying on the efficient utilization of resources [16]. However, sustainable competitiveness encompasses not only economic indicators but also encompasses intangible factors, such as ecology and environment [17–19]. Furthermore, sustainable competitiveness represents a multifaceted phenomenon encompassing economic, environmental, and social dimensions [20].

In the literature, numerous studies have been conducted to assess the sustainable competitiveness of countries, leveraging various indices. Among these indices are the European Regional Competitiveness Index [21], the Global Competitiveness Index [22–25], and the Global Sustainable Competitiveness Index [26]. Notably, the Global Sustainable Competitiveness Index (GSCI) created by the World Economic Forum is commonly featured among these studies. Unlike other indices, the GSCI is directly oriented toward countries' sustainable competitiveness and is compiled for all countries. Hence, this research employs this index. Additionally, there exist studies employing multi-criteria decision-making (MCDM) methodologies to evaluate the levels of sustainable competitiveness across countries [27,28]. These studies involve the determination of sustainable competitiveness rankings by considering diverse criteria and their respective weights. Furthermore, some studies employ data from the Global Competitiveness Index (GCI) reports to assess sustainable competitiveness [29].

From a methodological perspective, various approaches exist for assessing the sustainability competitiveness levels of countries. These approaches include statistical analyses [30], regression analyses [20], panel data analyses [31], cluster analyses [32], and MCDM studies [27]. Statistical and regression analyses examine the relationships between the sub-dimensions of sustainable competitiveness among countries. On the other hand, panel data analyses involve making predictions based on the relationships between the sustainability competitiveness levels of countries. Cluster analyses group countries based on their levels of sustainable competitiveness. In MCDM approaches, sustainability competitiveness variables are evaluated as criteria, and countries' sustainability competitiveness levels are determined according to these criteria. Through the decision problem determined by the MCDM approach, the differences between countries in terms of their sustainability competitiveness levels are identified, revealing their strengths and weaknesses. Therefore, this study adopts the MCDM approach.

In the GSCI reports published since 2012, sustainable competitiveness was evaluated by employing six core indicators for countries, namely natural capital (NC), resource efficiency and intensity (REI), social capital (SC), intellectual capital and innovation (ICI), economic sustainability (ES), as well as governance efficiency (GE). These indicators hold equal significance and collectively contribute to the assessment of sustainable competitiveness [33]. To assess Turkey's current sustainable competitiveness position, the GSCI 2022 report, focusing on emerging economies, is examined. This report represents the most up-to-date assessment of countries' sustainable competitiveness levels. Specifically, when scrutinizing Turkey's sustainable competitiveness level, it secures the 103rd, 139th, 96th, 25th, and 37th positions in the NC, REI, SC, ICI, ES, and GE indicators, respectively. It is noteworthy that Turkey exhibits its strongest performance in the ES indicator.

1.1. Aims and contributions of the study

The primary objective of this study is to ascertain Turkey's current standing in terms of sustainable competitiveness, as it aspires to become a leading economic power in its region, as well as to propose recommendations necessary for achieving this leadership role. To this end, a hybrid approach integrating the method based on the removal effects of criteria (MEREC) and alternative ranking order method accounting for two-step normalization (AROMAN) methods will be employed. The utilization of this hybrid method is driven by the intention to determine sustainable competitiveness by assigning varying weights to different criteria. The MEREC method offers several advantages compared to other methods. These advantages are as follows: (*i*) This method serves as an effective tool for solving complex decision-making problems, supporting the involvement of experts with varying levels of expertise. (*ii*) It employs a categorical-based evaluation approach, effectively incorporating decision-makers' intuitive approaches to evaluating criteria. (*iii*) The method facilitates more transparent and flexible participation by experts in the decision-making process. (*iv*) This method is characterized by its simplicity, as it can be applied with straightforward procedures and does not involve complex calculations. The AROMAN method provides certain advantages over other alternative ranking methods. These advantages include: (*i*) It allows for both quantitative and qualitative evaluation of alternatives. (*ii*) This method includes two different normalization processes, which not only strengthens the normalization process but also permits sensitivity analysis. (*iii*) This method offers a straightforward and practical alternative ranking approach, avoiding complex calculations. (*iv*) It enables the differentiation of cost and benefit-based criteria evaluations.

Furthermore, in this research, the MEREC-AROMAN hybrid method is developed to support countries in determining their sustainable competitiveness levels based on macro-level data using the MCDM approach. This approach takes into consideration criteria of varying

importance to assist countries in identifying their sustainability competitiveness positions. Consequently, it paves the way for the development of a decision model based on GSCI parameters, enabling the determination of sustainable competitiveness levels.

The contributions that this research can be outlined as follows:

(i) A novel approach is developed for determining the levels of sustainable competitiveness at the country level.
(ii) The sustainable competitiveness level of Turkey is delineated through a novel approach in comparison to its neighboring countries.
(iii) The MEREC-AROMAN method is employed for the first time in the literature, combining elements of hybridization to facilitate its application.
(iv) Recommendations are formulated for the development of strategies aimed at determining Turkey's position in the race for sustainable competitiveness and devising appropriate strategies accordingly.

1.2. Organization of the study

This article consists of six sections. The second section provides a review of the relevant literature. The third section elucidates the MEREC-AROMAN method. The fourth section presents the case study for Turkey and neighboring countries. The fifth section provides sensitivity analyses and provides practical insights. Finally, the sixth section presents major conclusions, recommendations, and limitations.

2. Literature review

The literature includes various studies addressing the topic of sustainable competitiveness. These studies have indicated that developing and developed nations adopt distinct approaches when formulating their sustainable competitiveness strategies.

Balkytė & Tvaronavičienė [34] proposed the inclusion of long-term unrevealed competitiveness potential in the development of the theoretical framework for the sustainable competitiveness index. Herciu & Ogrean [22] highlighted the key factors influencing the analysis of sustainable competitiveness in the European Union countries. Productive capital, human capital, social institutional capital, cultural/natural capital, infrastructural capital, and knowledge/creative capital were found as essential components of sustainable competitiveness.

Despotovic et al. [20] employed a regression model to examine the impact of social and environmental dimensions on global competitiveness, emphasizing the need to maintain a balance between economic progress and social and environmental expectations for sustainable economic development. Urbaniec [29] analyzed Poland's sustainable competitiveness position relative to other European countries. The study focused on the social and environmental indicators of the 2015 GCI report to assess sustainability. The findings indicated an improvement in Poland's sustainable competitiveness position in line with its overall competitiveness position.

Bilbao-Terol et al. [21] conducted a study on regional competitiveness in Spain. The sub-indicators of the competitiveness index were categorized as basic, efficiency, innovation, and environment. The authors employed the technique for order preference by similarity to ideal solution (TOPSIS) method to determine the sustainable competitiveness scores of the regions, which were then compared with their respective regional competitiveness scores. Janković-Milić and Jovanović [27] developed a novel methodology for calculating GSCI and redefined scores of countries. While GSCI assigned equal importance to its sub-factors, the proposed methodology assigned varying levels of importance to the sub-dimensions. Intellectual capital was identified as the most significant sub-dimension. Notably, disparities were observed between the GSCI country ranking and the proposed GSCI country ranking.

Möbius & Althammer [35] examined sustainable competitiveness data encompassing 272 regions across 28 European countries. Their analysis highlighted the necessity of achieving simultaneous ecological, social, and economic development in these regions to attain long-term sustainable competitiveness outcomes. Fedajev et al. [36] employed clustering techniques to group countries based on their sustainable competitiveness scores and sub-dimension scores. The results yielded two distinct clusters, with countries in the first cluster displaying lower GSCI scores and those in the second cluster exhibiting higher scores. The study offered specific recommendations primarily targeting the subset of countries with lower GSCI scores.

The literature review indicates that the GCI and GSCI indices are commonly utilized. However, in studies employing the GCI index, various sustainability-related variables were incorporated as parameters to highlight the sustainability dimension. Although the findings at this juncture suggested sustainable competitiveness, they might not fully capture it. Furthermore, in research utilizing MCDM, there is an emerging necessity to apply updated and more precise MCDM methodologies for determining countries' sustainability competitiveness levels. Several studies opt for using the GSCI index in conducting comprehensive research. The prime rationale for this practice lies in the high reliability of GSCI and its methodological alignment with pertinent parameters. Furthermore, the compilation of this index by incorporating data from reputable sources such as the World Bank, the IMF, and diverse UN agencies underscores its robust foundation. One of the key advantages of this index is that it facilitates the comparability of competitiveness levels on both national and international scales, utilizing the dataset. It also opens avenues for novel research endeavors that delve into the relationships between national macro-level data and competitiveness. In this study, the aim is to conduct a regional competitiveness comparison, with a specific focus on Turkey, employing MCDM approaches, thereby enhancing awareness of Turkey's regional positioning.

3. The MEREC-AROMAN method

The MEREC method, introduced by Keshavarz-Ghorabaee et al. [37], is a novel approach that systematically examines the impact of each criterion on the alternatives by progressively removing them from the evaluation process. Through this method, a weight assigned to each criterion is determined based on its minimal effect on alternatives. Despite being a recently developed technique, the MEREC method has gained significant attention and has been widely applied to various multi-criteria selection problems within a relatively short timeframe. Examples of its applications encompass diverse areas such as distribution center location selection [38], identification of optimal refrigerants [39], evaluation of machining processes [40], analysis of battery energy storage systems [41], assessment of financial performance in the hotel and tourism industry [42], offshore wind farm site selection [43], determination of optimal solid-state drives [44], identification of optimal drilling parameters [45], selection of e-commerce development strategies [46], customer analytics [47], material selection [48], renewable energy power plant location selection [49], and sustainable policy selection problems [50].

The AROMAN method is an innovative approach developed to address the need for effective decision-making in multi-criteria environments. This method incorporates a two-step normalization process to ensure equitable and unbiased comparisons among alternatives [51]. AROMAN facilitates the generation of a comprehensive ranking order of alternatives by considering the relative importance of criteria and their respective weights [52].

The method MEREC-AROMAN method enables the evaluation of alternative options by systematically removing criteria one by one and determining their relative weights based on the least impact on the alternatives. It consists of two stages and a total of 12 steps. In the first stage, the six steps of the MEREC method are applied to weigh the

criteria. In the second stage, the six steps of the AROMAN method are implemented to rank the alternatives. The sequential application steps of this method are as follows:

First Stage: The MEREC method is performed in six steps. These steps are as follows:

Step 1. The decision matrix (Z) is constructed using Eq. (1), wherein the matrix comprises n criteria ($j = 1, 2, ..., n$) and m alternatives ($i = 1, 2, ..., n$):

$$Z = \begin{bmatrix} z_{11} \cdots z_{1j} \cdots z_{1n} \\ \vdots \cdots \vdots \cdots \vdots \\ z_{i1} \cdots z_{ij} \ldots z_{in} \\ \vdots \cdots \vdots \cdots \vdots \\ z_{m1} \cdots z_{mj} \ldots z_{mn} \end{bmatrix}. \tag{1}$$

Step 2. The normalized decision matrix (N_{ij}^{x}) is computed using Eq. (2):

$$N_{ij}^{x} = \begin{cases} \dfrac{\min\limits_{i} z_{ij}}{z_{ij}}, \text{for benefical criteria} \\ \dfrac{z_{ij}}{\max\limits_{i} z_{ij}}, \text{for cost criteria} \end{cases}, \forall i, j. \tag{2}$$

Step 3. The overall performance values (S_i) of the alternatives are determined using Eq. (3):

$$S_i = \ln\left(1 + \left(\frac{1}{m}\sum_{j}\left|\ln\left(N_{ij}^{x}\right)\right|\right)\right), \forall i. \tag{3}$$

Step 4. The partial performance values ($S_{ij}^{'}$) of the alternatives are computed by subtracting each criterion from the overall performance values, as described in Eq. (4):

$$S_{ij}^{'} = \ln\left(1 + \left(\frac{1}{m}\sum_{k,k\neq j}\left|\ln\left(N_{ij}^{x}\right)\right|\right)\right), \forall i, j. \tag{4}$$

Step 5. The sum of absolute deviations (E_j) is determined by applying Eq. (5):

$$E_j = \sum_{i}\left|S_{ij}^{'} - S_i\right|, \forall j. \tag{5}$$

Step 6. The criteria weights (w_j) are calculated using Eq. (6):

$$w_j = \frac{E_j}{\sum\limits_{k} E_k}, \forall j. \tag{6}$$

Second Stage: The AROMAN method is performed in six steps. These steps are as follows:

Step 7. The linear normalization (K_{ij}) process is performed using Eq. (7):

$$K_{ij} = \frac{z_{ij} - \min\limits_{i} z_{ij}}{\max\limits_{i} z_{ij} - \min\limits_{i} z_{ij}}, \forall i, j. \tag{7}$$

Step 8. The vector normalization ($K_{ij}{}^{*}$) process is performed using Eq. (8):

$$K_{ij}{}^{*} = \frac{z_{ij}}{\sqrt{\sum_{i=1}^{m} z_{ij}^{2}}}, \forall i, j. \tag{8}$$

Step 9. The aggregated normalization ($K_{ij}{}^{norm}$) process is conducted using Eq. (9):

$$K_{ij}{}^{norm} = \frac{\beta K_{ij} + (1-\beta) K_{ij}{}^{*}}{2}, \forall i, j, \tag{9}$$

where β represents a weighting factor that takes values between 0 and 1.

Step 10: The values obtained through the aggregated normalization process are multiplied by the criterion weights as shown in Eq. (10):

$$\widehat{K_{ij}} = w_j * K_{ij}{}^{norm}, \forall i, j. \tag{10}$$

Step 11: The cost criteria, which are intended to be minimized, are calculated using the operation shown in Eq. (11):

$$L_i = \sum_{j=1}^{n} \widehat{K_{ij}}^{(min)}, \forall i, \tag{11}$$

while the benefit criteria, which are intended to be maximized, are calculated using the operation shown in Eq. (12), to obtain the normalized weighted values:

$$P_i = \sum_{j=1}^{n} \widehat{K_{ij}}^{(max)}, \forall i, \tag{12}$$

Step 12: The value of R_i is calculated using Eq. (13) to determine the ranking of alternatives:

$$R_i = L_i{}^{\lambda} + P_i{}^{(1-\lambda)}, \forall i, \tag{13}$$

where the alternative with the highest R_i value is identified as the best alternative. The parameter λ represents the coefficient of criterion variety and can be used with various variations. However, to avoid obtaining undefined results in an MCDA problem consisting solely of benefit or cost criteria, the value of λ can be accepted as 0.5.

4. Case study for Turkey and neighboring countries

In this section, the proposed model for comparing the sustainability competitiveness levels of neighboring countries is applied through a case study. The case study involves a comparison between Turkey and its neighboring countries. It comprises three sub-sections: the first sub-section defines the criteria, the second sub-section provides information about Turkey and the neighboring countries, and the third sub-section presents the application steps of the model and the obtained results.

4.1. Definition of criteria

The notion of sustainable competitiveness encompasses a broader framework, within which a concept introduced by the World Economic Forum has been delineated. This concept is characterized as the amalgamation of institutions, regulations, and other constituents that collectively foster long-term productivity in a country while simultaneously advancing social and environmental sustainability [53]. Since 2012, GSCI has employed a set of 131 quantitative indicators sourced from reputable international organizations to evaluate national development and green growth, thereby offering a comprehensive assessment of a country's potential. These indicators are organized into six key pillars:

- ***Natural capital*** (C_1) – The concept of NC plays a pivotal role in providing environmental services and serving as a source of natural resource inputs for economic development. These assets encompass

natural resource stocks, land, and ecosystems, which are commonly recognized as the primary constituents of natural capital. These components are deemed indispensable for the long-term sustainability of development, as they possess the potential to fulfill various functions for both human beings and other living organisms within and beyond the realm of the economy [54]. The components of NC encompass agriculture (including available land, yield efficiency, degradation, and desertification), biodiversity (comprising forests, fauna, and biodiversity pressure), water (encompassing renewable and non-renewable freshwater resources, as well as agricultural water usage), resources (including energy and mineral resources, as well as resource depletion), and pollution (encompassing water pollution, biodiversity pollution, and air pollution) [33].

- ***Resource efficiency and intensity*** (C_1) – REI pertains to the sustainable utilization of the Earth's finite resources while minimizing adverse environmental impacts. It encompasses the ability to generate greater value and output with reduced effort. Resource utilization, defined as the proportion of available resources currently employed, assumes significance in this context. Efficient resource management planning can enhance operational efficiency, enabling companies to function optimally [55]. Both employers and workers stand to benefit from effective resource management. On the one hand, it mitigates the risk of overwork and burnout, fostering a more balanced work-life equilibrium. On the other hand, it ensures that workers have sufficient employment opportunities to sustain their livelihoods and achieve profitability. Efficient resource utilization capacity, irrespective of the abundance or scarcity of capital, plays a determining role. Resource efficiency, as a cost factor, influences a nation's competitiveness and, consequently, its economic prosperity, regardless of whether the nation possesses natural resources or other forms of resources within its borders. Moreover, the overexploitation of natural resources not only impacts a nation's competitiveness but also jeopardizes its ability to sustain its population and economy with essential resources in the future. The components of REI encompass energy (fossil fuels, electricity, renewable energy sources), water (including water availability per capita, water withdrawal rate, and water productivity), and raw materials (encompassing resources per capita, resources per GDP, and resource balance) [33].
- ***Social capital*** (C_3) – SC refers to the institutions, connections, and standards that influence the quantity and quality of social interactions within a community [56]. Growing evidence highlights the significance of social cohesion for sustainable growth and economic prosperity within societies. SC serves as the cohesive force that unifies and strengthens the fabric of a society, transcending the mere summation of its constituent institutions. Its components encompass health (comprising access to healthcare, child mortality rates, and family planning), equality (encompassing income equality, resource distribution equality, and gender equality), crime (including theft, violent crime rates, and prison population), freedom (encompassing press freedom, human rights, and instances of violent conflicts), and satisfaction (comprising individual happiness, suicide rates, and public service satisfaction) [33].
- ***Intellectual capital and innovation*** (C_4) – ICI encompasses the intangible ideals harbored by individuals, businesses, organizations, communities, and regions, forming the foundation for wealth creation, sustenance of livelihoods, and improvement of future well-being [57]. It represents a concealed, elusive, and ethereal form of capital inherent to a nation. Its primary resources consist of the knowledge, insights, wisdom, experiences, talents, and creativity of individuals [58]. Employment opportunities and income generation play a crucial role in the creation and preservation of wealth. The production of goods and provision of services that individuals or businesses desire to acquire, both domestically and internationally, are vital for job creation. To attain a competitive advantage in the global market, it becomes imperative for goods and services to excel in terms of quality and cost. Maximizing domestic advantages necessitates a comprehensive examination of the value chain within the national economy, as a substantial portion of added value resides in the transformation of raw materials and/or components into finished products. The components of ICI encompass education (encompassing school enrollment, academic performance, and school infrastructure), research and development (encompassing capital allocation, tertiary education, and performance indicators), and new business (comprising new business registrations, high-tech manufacturing, and trademarks) [33].
- ***Economic Sustainability*** (C_5) – The objective of ES is to achieve economic growth while minimizing adverse environmental trade-offs. It encompasses a comprehensive framework of ES principles and corporate practices [59]. The overarching goal of sustainable development is to devise operational systems that gradually utilize natural capital, ensuring the sustainable utilization of these resources by future generations [60,61]. The components of ES encompass the business environment (comprising infrastructure, legal security, and financial capacity), business competitiveness (encompassing sectoral equilibrium, economic focus, and business diversity), female participation (involving women in the labor force, women in management positions, and economic diversity), financial markets (encompassing stability, exposure to volatility, and legal framework), and economic indicators (including gross national income, growth rate, and market indicators) [33].
- ***Governance Efficiency*** (C_6) – The governance process encompasses collaborative problem-solving and meeting societal demands. In the context of fostering ongoing competitiveness, GE assesses the effectiveness of a country's infrastructure and regulatory framework. The components of GE encompass government cohesion (encompassing public services, educational budget, and military spending), infrastructure (including investments, roads, rail, and transmission), business environment (comprising ease of doing business, business registration, and sector developments), corruption (evaluating the corruption index and red tape), and financial stability (encompassing austerity measures, exposure to financial shocks, and financial regulation) [33].

4.2. Definition of alternative countries

As part of a methodological approach to determine Turkey's level of sustainable competitiveness compared to neighboring countries, alternative countries were selected. The primary objective was to assess and compare the sustainable competitiveness between Turkey and these selected countries. In this context, information was provided about Turkey and its neighboring countries.

- ***Greece*** (A_1) – Situated to the western periphery of Turkey, Greece occupies a prominent position on the Balkan Peninsula. The historical and cultural affinities between these two nations have fostered a sense of interconnectedness. It is worth noting that certain territorial disputes persist in the bilateral relations of Turkey and Greece. However, these contentions notwithstanding, the overall state of economic and touristic affairs remains robust.
- ***Bulgaria*** (A_2) – Positioned in the Balkans, to the northwestern vicinity of Turkey, Bulgaria assumes a significant geographic placement that has engendered an extensive historical and cultural interplay in the border region shared by the two nations. The economic and touristic linkages between Turkey and Bulgaria carry considerable weight in bilateral relations, signifying their importance in fostering mutual exchange and engagement.
- ***Turkey*** (A_3) – It is located at the crossroads of the Asia and European continents. Also, provides direct access to the African continent. It is bordered by eight countries that are subjected to the current study. The country is strategically positioned between the Mediterranean Sea to the south and west, and the Black Sea to the north, offering

access to multiple maritime trade routes. Thanks to its geographical position it has posed an enabler role for the intercontinental trade routes for ages.

- ***Georgia*** (A_4) – Positioned within the Caucasus region, to the northeast of Turkey, Georgia occupies a distinctive geographic position. Turkey and Georgia have forged a strategic partnership that encompasses a spectrum of collaborative endeavors and shared objectives. The border region shared by these two nations serves as a dynamic conduit, embodying a vibrant transit hub crucial for the facilitation of pivotal trade channels and vital energy arteries.
- ***Armenia*** (A_5) – Situated in the South Caucasus, to the eastern expanse of Turkey, Armenia assumes its geographic position. The bilateral relations of Turkey and Armenia are marred by historical and political contentions. Notably, the border gates connecting the two countries remain predominantly closed, signifying restricted cross-border activities. However, it is worth acknowledging that certain diplomatic advancements have been witnessed in recent years, indicative of nascent dialogues and potential avenues for engagement.
- ***Azerbaijan*** (A_6) – Azerbaijan, situated in the South Caucasus, shares strong historical, cultural, and fraternal ties with Turkey. The bilateral relationship between Turkey and Azerbaijan is characterized as a strategic partnership, encompassing significant cooperation in energy, trade, defense, and culture. Transportation projects such as the Baku-Tbilisi-Kars railway serve as crucial links between the two nations. Collaborative efforts include projects like the Baku-Tbilisi-Ceyhan oil pipeline and the Trans-Anatolian Natural Gas Pipeline for secure and sustainable energy transportation. Additionally, Turkey provided political and military support to Azerbaijan during the 2020 Nagorno-Karabakh War. In summary, the relations between Turkey and Azerbaijan are strategically driven, marked by mutual support and cooperation, underscoring their strong bond.
- ***Iran*** (A_7) – Situated to the eastern periphery of Turkey, Iran assumes its geographic position within the Middle East. Turkey and Iran share a historical and cultural affinity that has fostered enduring bonds between the two nations. Of noteworthy significance is the substantial trade volume between these countries, exemplifying the strategic importance of their economic interdependence. Furthermore, Turkey and Iran engage in collaborative efforts in the realms of energy and transportation, showcasing a concerted drive towards bilateral cooperation in these crucial sectors.
- ***Syria*** (A_8) – Syria, situated in the Middle East, represents a complex and volatile relationship with Turkey. The civil war in Syria and its aftermath have significantly impacted bilateral relations. Turkey has provided shelter and humanitarian aid to millions of Syrian refugees, assuming an active role in addressing their basic needs. Security concerns hold a crucial place in Turkey-Syria relations, with Turkey striving to secure its borders against terrorist organizations. Moreover, Turkey engages in international efforts to stabilize Syria and safeguard the well-being of the Syrian population. Political and territorial disputes exist between the two countries, as Turkey advocates for a democratic transition and reconciliation process in Syria. The fluid nature of the Syrian civil war and subsequent developments have heightened the intricacy and unpredictability of Turkey-Syria relations. This information provides a concise overview of Syria as a neighboring country to Turkey. It is important to remain updated on current developments as the relationship between Turkey and Syria is subject to rapid changes.
- ***Iraq*** (A_9) – Positioned in the southeastern realm of Turkey, Iraq occupies a prominent geographic placement within the Middle East region. The historical, cultural, and economic linkages between Turkey and Iraq have fostered enduring connections between the two nations. Notably, the substantial volume of trade between these countries attests to their deepening economic interdependence, while their collaborative endeavors in the realm of energy signify a concerted effort towards cooperation. Furthermore, Turkey has proactively undertaken diverse initiatives aimed at providing humanitarian aid to Iraq, alongside concerted cooperation in combating terrorism, thereby underscoring their joint commitment to addressing shared security concerns.

4.3. Results of the sustainable competitiveness ranking

This research aimed to compare the sustainable competitiveness rankings of Turkey and its border neighbors using the proposed MEREC-AROMAN method. The study utilized six criteria based on GSCI indicators: natural capital (C_1), resource efficiency and intensity (C_2), social capital (C_3), intellectual capital and innovation (C_4), economic sustainability (C_5), and governance efficiency (C_6). Nine countries were included in the analysis: Greece (A_1), Bulgaria (A_2), Turkey (A_3), Georgia (A_4), Armenia (A_5), Azerbaijan (A_6), Iran (A_7), Syria (A_8), and Iraq (A_9). The case study was conducted in several phases, involving the weighting of the six criteria in the first stage and the ranking of the nine countries in the second stage. The process is illustrated in Fig. 1.

The steps of the MEREC–AROMAN application are as follows:

Step 1. The values of Turkey and its neighboring countries regarding the criteria were obtained from the GSCI 2022 report. The decision matrix (Z) was constructed by using these values and Eq. (1). The matrix is presented in Table 1.

Step 2. The normalized decision matrix was computed using Eq. (2). The resulting matrix is presented in Table A.1 in Appendix A. All criteria in the study are considered beneficial.

Steps 3–5. First, the S_i values (Table A.2) were derived using Eq. (3). Second, the $S_{ij}^{'}$ values (Table A.3) were calculated using Eq. (4). Third, the E_j values (Table A.4) were computed using Eq. (5).

Step 6. Criterion weights were calculated by Eq. (6). They are shown in Table 2.

Steps 7–11. First, the linear normalization (Table A.5) was performed using Eq. (7). Second, the vector normalization (Table A.6) was performed using Eq. (8). Third, the aggregated normalization (Table A.7) was performed using Eq. (9). Fourth, the aggregated weighted normalization (Table A.8) was obtained using Eq. (10).

Step 12. The R_i values and alternative rankings of the countries were determined using Eq. (13). The rankings of the countries based on sustainable competitiveness are presented in Table 3.

5. Discussion

This section provides sensitivity analyses and practical insights. Sensitivity analyses are conducted based on scenario creation, with robustness tests applied to each scenario. The findings are then discussed in comparison with the research results. Practical implications are derived from the obtained results, and recommendations are formulated for enhancing Turkey's sustainability competitiveness.

5.1. Sensitivity analyses

Sensitivity analyses were conducted to test the accuracy of the findings obtained through the MEREC-AROMAN method. They were scenario-based. Two approaches were adopted in creating the sensitivity analysis scenarios. In the first approach, the criteria identified for the sustainable competitiveness levels of countries were individually removed from the criteria list to obtain criterion weights and country rankings. In the second approach, variations in λ and β, as used in the AROMAN method, were considered to obtain alternative rankings.

In the first approach, six scenarios were identified, where criteria were successively removed. The resulting criterion weights and alternative rankings are presented in Table 4. The obtained results for each scenario are as follows:

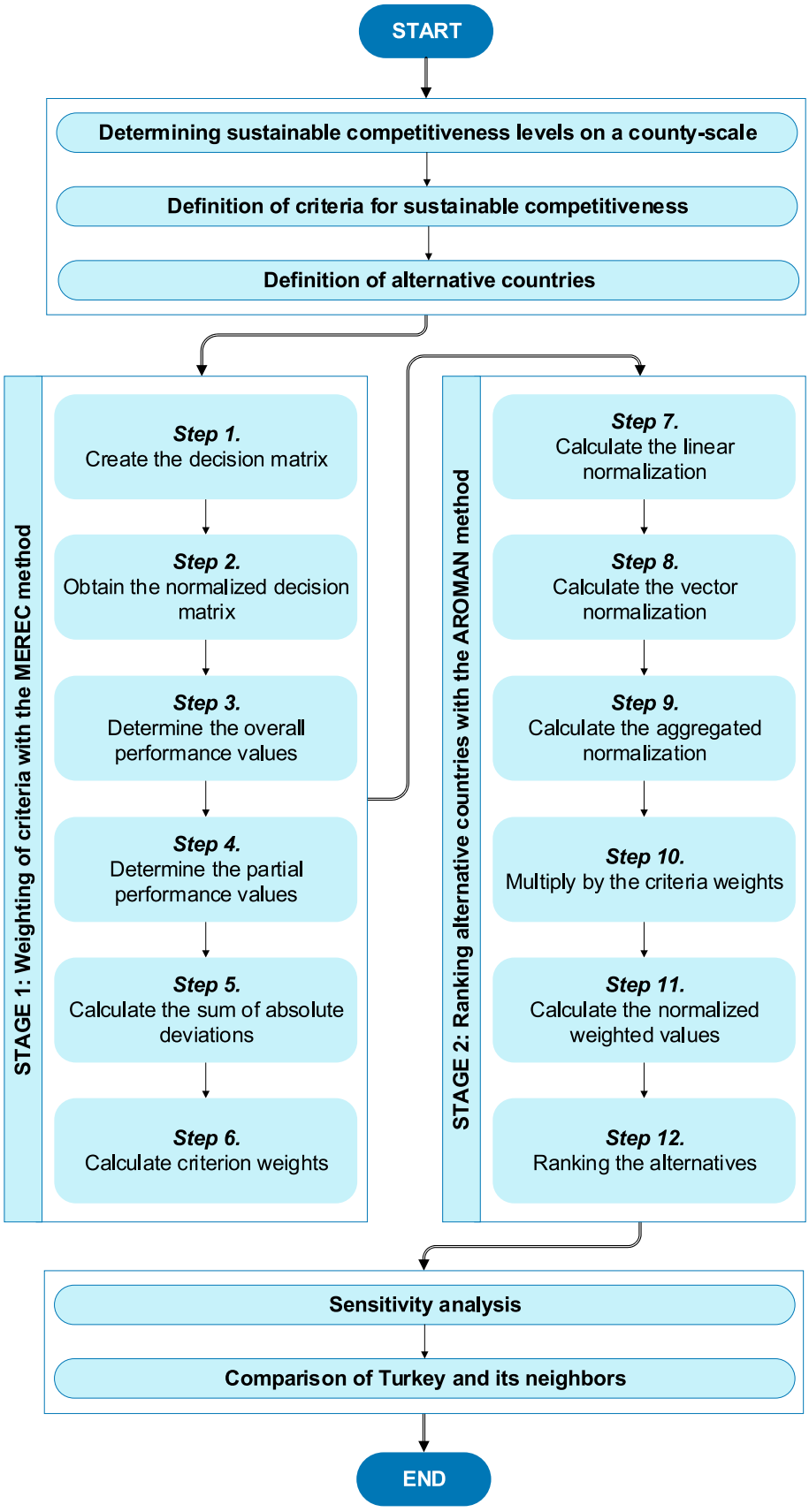

Fig. 1. The application flowchart.

Table 1
The decision matrix.

Alternatives	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
Greece (A_1)	36.3	49.8	53.5	43.4	52.1	59.0
Bulgaria (A_2)	45.9	41.6	49.7	40.9	47.1	57.9
Turkey (A_3)	38.3	40.2	43.4	52.6	50.3	45.5
Georgia (A_4)	49.2	38.8	49.1	39.7	40.4	50.2
Armenia (A_5)	34.6	39.9	59.8	32.8	39.1	52.2
Azerbaijan (A_6)	34.9	36.9	47.2	38.7	33.5	35.6
Iran (A_7)	32.9	23.1	38.4	54.9	32.0	41.3
Syria (A_8)	32.4	37.9	37.1	29.3	32.4	28.0
Iraq (A_9)	29.7	27.7	37.6	29.3	36.7	31.6

Table 2
The criterion weights.

Criteria	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
Weight	0.1138	0.2580	0.1109	0.1630	0.1157	0.2386
Ranking	5	1	6	3	4	2

Table 3
The final values and the ranking.

Alternatives	Greece (A_1)	Bulgaria (A_2)	Turkey (A_3)	Georgia (A_4)	Armenia (A_5)	Azerbaijan (A_6)	Iran (A_7)	Syria (A_8)	Iraq (A_9)
R_i	0.3052	0.2760	0.2485	0.2408	0.2236	0.1601	0.1451	0.1066	0.0880
Ranking	1	2	3	4	5	6	7	8	9

Table 4
The sensitivity analysis scenario results.

Scenarios	C_1	C_2	C_3	C_4	C_5	C_6	Ranks
Scenario-1	–	0.2918	0.1248	0.1839	0.1301	0.2695	$A_1 \succ A_2 \succ A_3 \succ A_5 \succ A_4 \succ A_6 \succ A_7 \succ A_8 \succ A_9$
Scenario-2	0.1535	–	0.1503	0.2176	0.1566	0.3220	$A_1 \succ A_2 \succ A_3 \succ A_4 \succ A_5 \succ A_7 \succ A_6 \succ A_9 \succ A_8$
Scenario-3	0.1276	0.2913	–	0.1824	0.1297	0.2691	$A_1 \succ A_2 \succ A_3 \succ A_4 \succ A_5 \succ A_6 \succ A_7 \succ A_8 \succ \succ A_9$
Scenario-4	0.1360	0.3075	0.1316	–	0.1379	0.2870	$A_1 \succ A_2 \succ A_4 \succ A_5 \succ A_3 \succ A_6 \succ A_8 \succ A_7 \succ A_9$
Scenario-5	0.1282	0.2926	0.1250	0.1839	–	0.2702	$A_1 \succ A_2 \succ A_4 \succ A_3 \succ A_5 \succ A_6 \succ A_7 \succ A_8 \succ A_9$
Scenario-6	0.1493	0.3378	0.1462	0.2146	0.1521	–	$A_1 \succ A_3 \succ A_2 \succ A_4 \succ A_5 \succ A_6 \succ A_7 \succ A_8 \succ A_9$

- *Scenario 1* – When the "natural capital" (C_1) criterion was removed, the rankings of Georgia (A_4) and Armenia (A_5) changed. This suggests that the impact level of the first criterion enhances Georgia's competitiveness and indicates that NC is an important competitiveness criterion for Georgia in terms of sustainable competitiveness.
- *Scenario 2* – The removal of the "resource efficiency and intensity" (C_2) criterion resulted in a change in the rankings of Azerbaijan (A_6) and Iran (A_7). Additionally, the rankings of Syria (A_8) and Iraq (A_9) also changed. This indicates that the second criterion has a significant impact on the sustainable competitiveness of Iran and Iraq, highlighting the importance of REI as a key competitiveness factor for these countries.
- *Scenario 3* – When the "social capital" (C_3) was removed, the rankings of Azerbaijan (A_6) and Iran (A_7) changed. Additionally, the rankings of Syria (A_8) and Iraq (A_9) also changed. This indicates that the impact level of the second criterion enhances the competitiveness of Iran and Iraq in terms of sustainable competitiveness. It can be concluded that SC is an important competitiveness criterion for Iran and Iraq.
- *Scenario 4* – When the "intellectual capital and innovation" (C_4) criterion was removed, the rankings of Turkey (A_3) and Iran (A_7) declined. This suggests that the impact level of the third criterion plays a significant role in the competitiveness of Turkey and Iran in terms of sustainable competitiveness.
- *Scenario 5* – When the "economic sustainability" (C_5) criterion was removed, the ranking of Turkey (A_3) decreased by one position. This indicates that the EC is important for Turkey in terms of sustainable competitiveness.
- *Scenario 6* – When the "governance efficiency" (C_6) criterion was removed, the ranking of Bulgaria (A_2) decreased by one position. This suggests that GE is important for Bulgaria in terms of enhancing competitiveness.

In the second approach, variations in λ and β were observed to result in changes in the alternative country rankings. These changes are presented in Table S.1 in Supplementary Material. It was found that an increase in the λ value corresponded to an increase in the R_i values for all β variations. Additionally, an increase in the β value led to an increase in the R_i values for all λ variations. However, no differentiation was observed in the country rankings. Consequently, these findings support the results obtained through the MEREC-AROMAN method.

5.2. Practical insights

Determining national-level competitive strategies provides insights into countries' competitiveness levels and offers advantages in market conditions to countries under intense competitive pressures [8]. Thus, it requires a sustainable perspective which indicates the environmental

competitiveness of countries. This research is based on evaluating Turkey's sustainable competitiveness compared to its border neighbors. Data for Turkey and neighboring countries were obtained from GSCI. According to GSCI, all sub-components are shown at the same level of importance in determining the sustainable competitiveness of countries. However, a recent study suggests that indicators may have different significance levels and GSCI data can be calculated more accurately [27]. The approach presented in this study is compatible with this recommendation. In this direction, GSCI indicators of Turkey and border countries were accepted as criteria and re-weighted. The MEREC method was used to weigh the criteria. The ranking of the countries was carried out using the AROMAN method.

According to the findings of MEREC, the criteria weight order is as follows: REI ($w_2 = 0.2580$), GE ($w_6 = 0.2386$), ICI ($w_4 = 0.1630$), ES ($w_5 = 0.1157$), NC ($w_1 = 0.1138$), and SC ($w_3 = 0.1109$). In various studies in the literature, different criteria weight rankings were determined [62,63]. REI is of the highest importance criterion in this study. This finding indicates that the most important factors affecting the sustainable competitiveness of Turkey and its border neighbors are energy, water, and raw materials resources. It was found that the second important criterion was "governance efficiency" (C_6). Accordingly, governments' budget expenditure distributions, investment decisions, corruption, and financial stability have higher importance than other criteria in gaining sustainable competitive advantage.

The sustainable competitiveness rankings of Turkey and neighboring countries were determined by the AROMAN method. The sustainable competitiveness rankings are as follows: Greece ($R_1 = 0.3052$), Bulgaria ($R_2 = 0.2760$), Turkey ($R_3 = 0.2485$), Georgia ($R_4 = 0.2408$), Armenia ($R_5 = 0.2236$), Azerbaijan ($R_6 = 0.1601$), Iran ($R_7 = 0.1451$), Syria ($R_8 = 0.1066$), Iraq ($R_9 = 0.0880$). According to GSCI scores, when the rankings of the countries are compared with the GSCI rankings, it is seen that they are the same.

In terms of the NC indicator, when Turkey and its neighbors are compared, Turkey is behind Bulgaria and Georgia. However, Turkey's NC indicator power is higher than Greece, Armenia, Azerbaijan, Iran, Syria, and Iraq. In terms of the REI indicator, while Turkey's score is lower than Greece and Bulgaria, it is higher than Georgia, Armenia, Azerbaijan, Iran, Syria, and Iraq. In terms of the SC indicator, Turkey's success is higher than Iran, Syria, and Iraq. But it is lower than the other five countries. In terms of the ICI indicator, only Iran has a higher score than Turkey, while Turkey is more successful than the other seven countries. Greece is more successful than Turkey in terms of the ES indicator. But Turkey is more successful than the other seven countries. In terms of GE, Turkey's success is higher than Azerbaijan, Iran, Syria, and Iraq, but lower than the other four countries.

Turkey's sustainable competitive position concerning its border neighbors was revealed. The obtained results from this research could serve as a rule of thumb for Turkey to improve its sustainable competitiveness. Turkey took third place in the general ranking. It ranks second in the ICI and ES criteria. It is third in the NC and REI criteria. It is fifth in the GE ranking. It is the sixth for the SC criterion. Considering these rankings, the implications for Turkey to have a stronger sustainable competitive power are as follows:

(i) According to its border neighbors, Turkey's most unsuccessful criterion is the SC indicator. Therefore, Turkey should make progress in the areas of healthcare availability, child mortality, family planning, income equality, resource equality, gender equality, theft, violent crime, prison population, press freedom, human rights, violent conflicts, individual happiness, suicide rate, and public service satisfaction. Strategic plans and programs specific to these issues should be developed.

(ii) Compared to its border neighbors, Turkey's second most unsuccessful criterion is the GE indicator. The Government of Turkey must make advancements in the following areas and make strategic decisions for the effective use of resources: investments, roads and rail, transmission, ease of doing business, business registration, sector developments, austerity, exposure to financial shocks, as well as financial regulation.

(iii) Turkey has above-average power compared to its border neighbors in the NC and REI criteria. For this reason, it is suggested to increase the steps taken for the effective use of natural capital and resources.

(iv) Turkey is behind only Greece in ICI and ES criteria. Therefore, Turkey needs to take competitive steps to be more successful in the following issues: education, R&D and high-tech manufacturing, finance ability, economic focus, business diversity, women in labor, women in management, economic diversity, as well as stability and growth.

6. Conclusions

This research proposed the novel MEREC-AROMAN methodology for determining the levels of sustainable competitiveness at the country level. This hybrid method reduces uncertainties and complexity in calculations compared to other methods. It is considered advantageous due to the simultaneous use of two normalization methods for data set normalization and the development of solution proposals in this regard in the ranking of countries. It facilitates sensitivity analysis, allowing for the generation of results under different scenarios and enabling their comparison. On the other hand, this hybrid method imposes constraints by adopting vectorial and linear normalization techniques for normalization processes. At this point, the method can be further enhanced by incorporating different normalization techniques.

This research, aimed at determining sustainable competitiveness levels relative to neighboring countries, contributed to the academic field in multiple ways. First, the developed hybrid method offered an original scientific contribution to the literature on sustainable competitiveness research. Second, it raised awareness among countries about regional collaboration or competition in the context of regional sustainable competitiveness. Third, it paved the way for the development of policies and strategies related to sustainability, contributing to informed decision-making by countries. Fourth, the comparative analyses with neighboring countries could help countries identify their regional sustainable competitiveness levels and could assist in shaping international relations and trade studies accordingly. Last, it provided decision support, allowing academics and practitioners to deepen their understanding of sustainable competitiveness and make better-informed decisions.

Finally, this research has a few limitations. First, the scope of the research is Turkey and its border neighbors. Therefore, sustainable competitiveness scores of other countries were not considered. Second, only 2022 GSCI scores were used in this study. The authors did not consider previous years. Third, only GSCI indicators were considered, while other potential criteria were excluded from the scope of the study. Fourth, the research was only based on secondary data. It was assumed that the data obtained from the GSCI report reflects the truth and was prepared impartially.

CRediT authorship contribution statement

Karahan Kara: Methodology, Software, Validation, Formal analysis, Visualization, Data Curation, Project administration, Writing - Original Draft, Review & Editing. **Galip Cihan Yalçın:** Methodology, Software, Validation, Formal analysis, Visualization, Data Curation, Writing - Original Draft, Review & Editing. **Avni Zafer Acar:** Visualization, Writing - Original Draft, Review & Editing. **Vladimir Simic:** Resources, Visualization, Data Curation, Writing - Original Draft, Review & Editing. **Serkan Konya:** Investigation, Writing - Original Draft, Review & Editing. **Dragan Pamucar:** Visualization, Writing - Review & Editing.

Data availability

Data will be made available on request.

Appendix

Table A.1
The normalized decision matrix.

Alternatives	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
Greece (A_1)	0.8182	0.4639	0.6935	0.6751	0.6142	0.4746
Bulgaria (A_2)	0.6471	0.5553	0.7465	0.7164	0.6794	0.4836
Turkey (A_3)	0.7755	0.5746	0.8548	0.5570	0.6362	0.6154
Georgia (A_4)	0.6037	0.5954	0.7556	0.7380	0.7921	0.5578
Armenia (A_5)	0.8584	0.5789	0.6204	0.8933	0.8184	0.5364
Azerbaijan (A_6)	0.8510	0.6260	0.7860	0.7571	0.9552	0.7865
Iran (A_7)	0.9027	1.0	0.9661	0.5337	1.0	0.6780
Syria (A_8)	0.8182	0.4639	0.6935	0.6751	0.6142	0.4746
Iraq (A_9)	0.6471	0.5553	0.7465	0.7164	0.6794	0.4836

Table A.2
The overall performance values of the alternative countries.

Alternatives	Greece (A_1)	Bulgaria (A_2)	Turkey (A_3)	Georgia (A_4)	Armenia (A_5)	Azerbaijan (A_6)	Iran (A_7)	Syria (A_8)	Iraq (A_9)
S_i	0.4011	0.3787	0.3469	0.3394	0.3017	0.2144	0.1758	0.0945	0.0728

Table A.3
The partial performance values of the alternative countries.

Alternatives	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
Greece (A_1)	0.3784	0.3114	0.3594	0.3562	0.3451	0.3142
Bulgaria (A_2)	0.3278	0.3092	0.3448	0.3399	0.3336	0.2922
Turkey (A_3)	0.3165	0.2794	0.3283	0.2755	0.2921	0.2880
Georgia (A_4)	0.2776	0.2758	0.3055	0.3026	0.3113	0.2675
Armenia (A_5)	0.2827	0.2319	0.2410	0.2877	0.2767	0.2218
Azerbaijan (A_6)	0.1925	0.1493	0.1815	0.1763	0.2082	0.1816
Iran (A_7)	0.1614	0.1758	0.1710	0.0839	0.1758	0.120
Syria (A_8)	0.0812	0.0164	0.0945	0.0945	0.0926	0.0945
Iraq (A_9)	0.0728	0.0442	0.0707	0.0728	0.0513	0.0539

Table A.4
The sums of absolute deviations.

Criteria	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
E_j	0.2344	0.5316	0.2286	0.3358	0.2384	0.4916

Table A.5
The results of the linear normalization.

Alternatives	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
Greece (A_1)	0.3385	1.0	0.7225	0.5508	1.0	1.0
Bulgaria (A_2)	0.8308	0.6929	0.5551	0.4531	0.7512	0.9645

(*continued on next page*)

Table A.5 (*continued*)

Alternatives	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
Turkey (A_3)	0.4410	0.6404	0.2775	0.9102	0.9104	0.5645
Georgia (A_4)	1.0	0.5880	0.5286	0.4063	0.4179	0.7161
Armenia (A_5)	0.2513	0.6292	1.0	0.1367	0.3532	0.7806
Azerbaijan (A_6)	0.2667	0.5169	0.4449	0.3672	0.0746	0.2452
Iran (A_7)	0.1641	0.0	0.0573	1.0	0.0	0.4290
Syria (A_8)	0.1385	0.5543	0.0	0.0	0.0199	0.0
Iraq (A_9)	0.0	0.1723	0.0220	0.0	0.2338	0.1161

Table A.6
The results of the vector normalization.

Alternatives	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
Greece (A_1)	0.3216	0.4364	0.3812	0.3520	0.4230	0.4291
Bulgaria (A_2)	0.4066	0.3645	0.3541	0.3317	0.3824	0.4211
Turkey (A_3)	0.3393	0.3523	0.3092	0.4266	0.4084	0.3309
Georgia (A_4)	0.4359	0.340	0.3499	0.3220	0.3280	0.3651
Armenia (A_5)	0.3065	0.3496	0.4261	0.2660	0.3175	0.3797
Azerbaijan (A_6)	0.3092	0.3233	0.3363	0.3139	0.2720	0.2589
Iran (A_7)	0.2915	0.2024	0.2736	0.4452	0.2598	0.3004
Syria (A_8)	0.2870	0.3321	0.2644	0.2376	0.2631	0.2036
Iraq (A_9)	0.2631	0.2427	0.2679	0.2376	0.2980	0.2298

Table A.7
The results of the aggregated normalization with $\beta = 0.5$.

Alternatives	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
Greece (A_1)	0.1650	0.3591	0.2759	0.2257	0.3558	0.3573
Bulgaria (A_2)	0.3094	0.2644	0.2273	0.1962	0.2834	0.3464
Turkey (A_3)	0.1951	0.2482	0.1467	0.3342	0.3297	0.2239
Georgia (A_4)	0.3590	0.2320	0.2196	0.1821	0.1865	0.2703
Armenia (A_5)	0.1395	0.2447	0.3565	0.1007	0.1677	0.2901
Azerbaijan (A_6)	0.1440	0.2101	0.1953	0.1703	0.0867	0.1260
Iran (A_7)	0.1139	0.0506	0.0827	0.3613	0.0650	0.1824
Syria (A_8)	0.1064	0.2216	0.0661	0.0594	0.0707	0.0509
Iraq (A_9)	0.0658	0.1038	0.0725	0.0594	0.1330	0.0865

Table A.8
The results of the aggregated normalization with $\beta = 0.5$.

Alternatives	Natural capital (C_1)	Resource efficiency and intensity (C_2)	Social capital (C_3)	Intellectual capital and innovation (C_4)	Economic sustainability (C_5)	Governance efficiency (C_6)
Greece (A_1)	0.0188	0.0926	0.0306	0.0368	0.0412	0.0852
Bulgaria (A_2)	0.0352	0.0682	0.0252	0.0320	0.0328	0.0827
Turkey (A_3)	0.0222	0.0640	0.0163	0.0545	0.0382	0.0534
Georgia (A_4)	0.0408	0.0599	0.0244	0.0297	0.0216	0.0645
Armenia (A_5)	0.0159	0.0631	0.0396	0.0164	0.0194	0.0692
Azerbaijan (A_6)	0.0164	0.0542	0.0217	0.0277	0.010	0.0301
Iran (A_7)	0.0130	0.0131	0.0092	0.0589	0.0075	0.0435
Syria (A_8)	0.0121	0.0572	0.0073	0.0097	0.0082	0.0121
Iraq (A_9)	0.0075	0.0268	0.0080	0.0097	0.0154	0.0206

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.seps.2023.101762.

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