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# Ranking European Countries Using Hybrid MEREC-MARCOS MCDA Based on Travel and Tourism Development Index

## Abstract

Improving the conditions for the provision of tourist services is critical for the development of tourism. The World Economic Forum uses the Travel and Tourism Development Index (TTDI), calculated based on five main criteria and 17 sub-criteria, to assess these conditions and generate a ranking list of countries based on their favourable environment for conducting tourism-related activities. However, the TTDI only considers the average value of each country's criteria and sub-criteria scores without considering the significance of those criteria. This paper addresses this issue using a hybrid multi-criteria analysis, which combines the MARCOS (Measurement of Alternatives and Ranking According to Compromise Solution) and MEREC (MEthod based on the Removal Effects of Criteria) methods. The results of these methods show that the observed European countries' ranking order differs from the ranking order stated in TTDI. Spain is ranked first, Turkmenistan ranks last, and sensitivity analysis supports these findings. When ranking countries using the TTDI, the importance of the criteria must be considered to accurately reflect the conditions prevailing for tourism development in countries, which is highlighted by this research. This paper's contribution demonstrates that all criteria cannot be considered equally to form the TTDI, as the requirements cannot be equally important.

***Keywords***: travel & tourism development index, TTDI, MCDA, MEREC method, MARCOS method

## 1. Introduction

When individuals travel for leisure outside their usual residence, it is considered a "social, cultural, and economic phenomenon" widely known as tourism (World Tourism Organization [UNWTO], 2022). Tourism promotes economic growth (Song & Wu, 2021; Laiginhas Pina et al., 2023), but economic expansion can also positively influence tourism (Rozalia Gabor et al., 2023). Tourism is a driving force behind development, economic expansion, and employment opportunities in many nations. To keep a competitive advantage in the global tourism market, tourist destinations must continuously strive to improve. The increasing level of the tourism and travel industries competition on a worldwide scale, rising customer demands, and the emergence of new travel destinations are the motivating factors behind these objectives (Wang & Liu, 2020; Bazargani & Kiliç, 2021; Martínez-González et al., 2021). In 2022, The World Economic Forum (WEF) introduced ten principles of sustainable development to manage a destination for resilience and sustainability of the destination, the people, and the products it includes. When

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done correctly, destination management safeguards a location and the companies that depend on the travel sector (Febryano et al., 2022; Nilsson & Blom, 2023). If done poorly, it damages a location, its businesses, and everyone's experience there-including locals (Pavlov et al., 2023). Poor destination management can adversely affect communities, such as inflation, price bubbles caused by tourists' higher purchasing power, and livelihood losses (WEF, 2022). It can also cause excessive infrastructure usage, resulting in dangerous road conditions. Poor destination management can also fail to connect visitor sales and profits with local communities for long-term business growth and sustainable livelihoods. This results in adverse reactions where resources are squandered. Thus, according to Ozkaya and Demirhan`s (2022) research, the most critical concern in sustainable tourism is developing a solid tourism industry by addressing the social and environmental issues that come with tourism growth.

Competitiveness is regarded as one of the significant economic aspects of sustainability related to the travel and tourism industry, though it is frequently overlooked when understanding sustainable tourism (Ozkaya & Demirhan, 2022; Host, 2023). The Travel and Tourism Competitiveness Index (TTCI) report series, a flagship index of the WEF's "Platform for Shaping the Future of Mobility" for 15 years (Calderwood & Soshkin, 2019), has evolved into the Travel and Tourism Development Index (TTDI) in 2021 (Calderwood & Soshkin, 2021). This updated index provides valuable insights into individual countries' strengths and development achievements to improve the potential and growth of the tourism industry, serving as a strategic benchmarking instrument for policymakers, corporate entities, individual business owners, and others. Moreover, it provides a forum for multi-stakeholder discussion to comprehend and foresee emerging trends and risks in the global tourism industry, guide policies and procedures for investment options, and contribute to developing new models that secure the resilience of this significant sector. An important distinction is that the new TTDI measures potential drivers of travel and tourism development rather than the level of development that an economy achieves. The majority of the dataset for the TTDI is comprised of statistical information from numerous international organizations, and the remaining portion is based on survey information from the WEF's annual "Executive Opinion Survey".

However, we must not forget that sustainability successfully combined what were once considered incompatible concepts in developing and protecting resources and environments and gained a significant amount of its widespread acceptance (Butler, 2018). The limitations imposed by the environments, communities, and resource availability have a different impact on how travel and tourism develop. Experiencing change due to the economic benefits that tourism may bring should not be surprising. Still, it is essential to note that communities can be better prepared to withstand the pressures of tourism by increasing their resistance to unwelcome change, expanding their latitude in experiencing impact and lowering their level of precarity (Butler, 2018).

Several recent studies (Ağazade & Karasakaloğlu, 2023; Ozkaya & Demirhan, 2022; Rasethuntsa & Perks, 2022; Stanišić et al., 2022; Tjandrasa et al., 2022; Tleuberdinova et al., 2022; Uyar et al., 2023) on tourism competitiveness used the TTCI and, more recently, the TTDI, both published by the WEF, as baseline indicators. However, to rank countries using the TTDI, with its five main and 17 sub-criteria, only the average value of each country's scores for each criterion and sub-criterion are used, and the significance of those criteria is not considered. To conduct a hybrid multi-criteria analysis, the method based on the Removal Effects of Criteria (MEREC) and Measurement of Alternatives and Ranking according to the COmpromise Solution (MARCOS) methods is employed in this research.

This research assesses countries' competitiveness concerning TTDI using the multi-criteria decision-making (MCDM) methodology. The specific objectives of this paper are delineated as follows:

- To determine the weightings of criteria that contribute to evaluating countries' competitiveness in TTDI through the utilization of the MEREC method;

- To evaluate and rank European countries based on their TTDI performance utilizing the MARCOS method;
- To conduct a comparative analysis between the rankings derived from the TTDI report and those obtained utilizing MCDM methodologies and
- To define and explain the differences between these two orders.

This paper is organized as follows. After the introduction, this paper is divided into five sections: the Literature review, Methodology, Results, Discussion, and Conclusion. The Literature review will address the issues of the most utilized MDCA methods on the subject. A detailed description of the MEREC and MARCOS methods used to rank European countries based on TTDI will be presented as methodology. The findings will be summarized in the fourth section and discussed in the fifth section of this paper. The sixth section, which serves as the paper's conclusion, will include the most critical findings, their limitations, and recommendations for future research directions.

## 2. Literature review

The literature review section identifies the most recent studies on the topic of tourism competitiveness, with a focus on the methodologies used to generate the results.

Recently, there has been a notable rise in the utilization of the TTDI index across various scholarly works. Băbăț et al. (2023) conducted a comparative analysis between Romania, Bulgaria, and Hungary, aiming to enhance the competitiveness of tourism within Romania. Pantović et al. (2023) employed an entropy model to examine the sustainability of tourism in EU countries by leveraging the TTDI index. Vašaničová et al. (2023) investigated the impact of tourism competitiveness on GDP across 125 countries. In a study on Vietnam, Thao (2023) delved into competitiveness assessment to enhance tourism by utilizing TTDI data. Furthermore, Lusena-Ezera et al. (2023) scrutinized tourism enhancement in Latvia by developing a tourist information system, integrating insights from the TTDI dataset.

Based on a measurement of tourism destination competitiveness that covered the years 2000 to 2019, Pérez León et al. (2021) highlighted the significance of tourism development in Central American and Caribbean destinations by employing LNR, cluster analysis and aggregative approach. The research of Altıntaş (2021), assessing the destination competitiveness performances of nineteen countries in the Mediterranean basin using the TTCI values for 2019, adopted the methodology following Multi Atributive Ideal-Real Comparative Analysis (MAIRCA) and MARCOS methods. In their work, Liu et al. (2021) develop a country-based tourism competitiveness assessment instrument using different statistical approaches and the Fuzzy Analytic Hierarchy Process (AHP) to demonstrate how vital tourism policy development is. The purpose of the Bire et al. (2021) paper was to investigate a conceptual criteria framework for measuring the competitiveness of tourism destinations at the regional level. With a thorough literature review and in-depth interviews with tourism industry professionals, this study was carried out in the East Nusa Tenggara Province of Indonesia and with the help of the Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) developed a customized list of criteria for evaluating destination competitiveness. Škrinjarić (2021) paper's primary goals were a critical review of the relevant literature about assessing sustainable tourism in European nations and in-depth empirical research on delivering sustainable tourism by deploying Grey Relational Analysis (GRA) and Grey Systems Theory (GST). Lopes and Rodríguez-López (2022) employed a methodology that uses MCDM tools, namely the Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) and Geometrical Analysis for Interactive Aid (GAIA), to calculate the potential of Portuguese wellness travel to produce a thorough assessment and

ranking of the alternatives. This study aimed to rank ten thermal spas in Northern Portugal according to fifteen indicators, many of which were related to digital services. It contained tourism data collected between 2020 and 2022. Using information from the Travel and Tourism Development Report, Ozkaya and Demirhan (2022) aimed to give a general overview of the performance of the travel and tourism industry across 43 countries in Europe and Eurasia. As a result, the objective of this article was to assess the tourism sector-based policies put in place in European nations during the Covid-19 pandemic and to compare 43 countries in Europe and Eurasia based on 14 indicators referring to competitiveness in the tourism industry and sustainable travel by using *VIseKriterijumska Optimizacija I Kompromisno Resenje* (VIKOR), Entropy, Objective weights and Cluster analysis.

As observed through the literature review, various authors in the scientific literature have used the TTCI and TTDI data sets as the foundation for their research. Using the arithmetic mean to combine the factors, the overall TTDI score is calculated through successive aggregations of rating, starting at the indicator level and moving up through the pillar levels. Before being rated on a standard scale, the scores for each indicator are first normalized (Calderwood & Soshkin, 2021). However, the TTDI only considers the average value of each country's criteria and sub-criteria scores without considering the significance of those criteria. Thus, reviewed papers used different approaches to analyse these data sets.

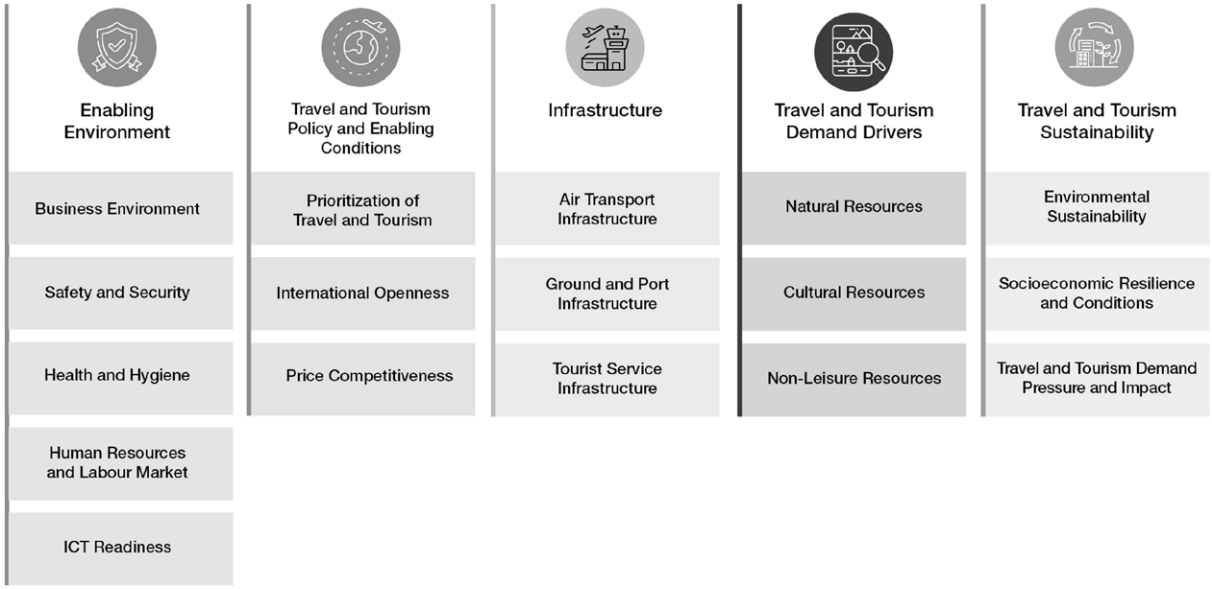
MEREC and MARCOS methods are applied to conduct a hybrid multi-criteria analysis in this research. These methods were suggested in various travel and tourism-related studies. The MARCOS method was used in the study (Puška et al., 2021) to rank rural settlements according to their potential for attracting tourists. Results from this study's application of the MARCOS model demonstrated how, in this particular instance, rural tourism could be improved. As the research model for evaluating tourism potential had produced positive results, the authors suggested that the method could be used in other tourism-related fields after modification for specific fields of tourism. Simic et al. (2024) introduced a two-stage MEREC-MARCOS model that would enable decision-makers to overcome a challenge with many competing requirements and express their ambiguous opinions during the decision-making process, particularly in the case of prioritizing sustainable climate change policies that affect not only urban transportation but also other human activities. A further study (Ghosh & Bhattacharya, 2022) examined the effects of the COVID-19 era on the business results of nine travel agencies and 22 hotels in India, which were assessed based on 14 different financial indicators. The study's (Taş & Çakir, 2022) objective was to choose among sustainable health tourism sites following the criteria used by decision-makers. It suggested a method, namely MARCOS, for evaluating sustainable health tourism locations. By examining tourists' restaurant experiences, the study (Darko & Liang, 2022) offered a comprehensive model for business owners and managers to understand diverse tourist attitudes. The probabilistic linguistic MARCOS decision-support method was employed in this study to help choose the ideal restaurant.

The MEREC and MARCOS methods will be presented in the methodology section in a stepwise manner.

# 3. Methodology and methods

When conducting this research, data on TTDI from 2021 will be used, and this data will be processed in the following manner. The 2021 TTDI is distinguished because all criteria are divided into five main categories: Enabling Environment, Travel and Tourism Policy and Enabling Conditions, Infrastructure, Travel and Tourism Demand Drivers, and Travel and Tourism Sustainability. All criteria are then subdivided into auxiliary criteria, with only the Enabling Environment criterion having five, while the other criteria have only three (Figure 1). The countries will first be divided into groups according to region, with only those parts of Europe being identified.

**Figure 1**
***Travel and tourism development index***




*Source*: Travel and Tourism Development Index for 2021.

The steps in conducting this research are as follows:

- Step 1. Formation of the initial decision matrix
- Step 2. Calculating criteria weights using the MEREC method
- Step 3. Ranking of countries using the MARCOS method
- Step 4. Conducting sensitivity analysis.

As the first step in all MCDA methods is forming the initial decision matrix (Więckowski et al., 2023; Saqlain, 2023), in this case, a preliminary decision-making matrix will be based on the TTDI, consisting of 43 European countries that are included in this report and 17 criteria from the original TTDI. The requirements will not be considered within the main criteria. However, all auxiliary criteria will be given equal weight, and a ranking of the European countries included will be formed based on them. All auxiliary criteria, illustrated in Figure 1, will be labelled from C1 to C17. The values for these countries based on these criteria will be taken from the TTDI report for 2021, forming the initial decision matrix. This decision matrix will be adopted using the MEREC and MARCOS approach.

Step 2 of this research, which is the formation of weights for the used criteria, is carried out after the initial decision-making matrix has been established, and the MEREC method will be utilized to calculate these weights. One of the techniques for objectively estimating the weight of criteria is the MEREC method. The weight of the requirements is determined by this method based on the value of the alternatives for the observed criteria in the initial decision matrix. The uniqueness of this method is that if the values of one criterion are more dispersed and vary more in comparison to another, the weight of that criterion will be more significant than that criterion. This method was developed by Keshavarz-Ghorabaee et al. (2021). The MEREC method is comprised of the following steps:

Step 1. Formation of the initial decision matrix.

Step 2. Normalization of the initial decision matrix. Although every criterion in the TTDI takes the form of a benefit criterion, the unique feature of this methodology is the use of cost normalization, in which all values are transformed into minimum values.

$$n_{ij} = \frac{x_{j\,min}}{x_{ij}} \tag{1}$$

Step 3. Calculating the total performance of the alternatives ($S_i$)

$$S_i = \ln\left(1 + \left(\frac{1}{m}\sum_j \left|\ln\left(n_{ij}^{x}\right)\right|\right)\right) \tag{2}$$

Step 4. Calculating the effects of alternatives for each criterion

$$S'_{ij} = \ln\left(1 + \left(\frac{1}{m}\sum_{k,k\neq j} \left|\ln\left(n_{ik}^{x}\right)\right|\right)\right) \tag{3}$$

Step 5. Calculation of the sum of deviations from absolute values

$$E_j = \sum_i \left|S'_{ij} - S_i\right| \tag{4}$$

Step 6. Calculation of final criteria weights.

$$w_j = \frac{E_j}{\sum_k E_k} \tag{5}$$

After determining the criteria weights, the third step of this research is to rank the European countries using the MARCOS method. This requires using the data from the initial decision matrix and the weights calculated by the MEREC method. The MARCOS method ranks alternatives in terms of ideal and anti-ideal solutions. These solutions represent other options' highest and lowest values according to specific criteria. The author Stević et al. (2020) designed the method, which consists of the following steps:

Step 1. Formation of the initial decision matrix.

Step 2. Expansion of the initial decision matrix (Stević et al., 2023). The initial decision-making matrix is expanded by introducing ideal and anti-ideal solutions. The maximum value of a given criterion represents the perfect solution, whereas the minimum value represents the anti-ideal solution.

Step 3. Normalization of the extended initial decision matrix. Given that all of the criteria are of the benefit type, with the criteria having a maximum value, the following normalization is used:

$$n_{ij} = \frac{x_{ij}}{x_{j\,max}} \tag{6}$$

Step 4. Weighting the decision-making matrix. Here, the normalized decision matrix is multiplied with the appropriate weights.

$$v_{ij} = n_{ij} \cdot w_j \tag{7}$$

Step 5. Alternative $K_i$ utility degree calculation. The utility degree is calculated using ideal and anti-ideal solutions.

$$K_i^- = \frac{S_i}{S_{aai}} \tag{8}$$

$$K_i^+ = \frac{S_i}{S_{ai}} \tag{9}$$

where (i=1,2,..,m) represents the sum of weighted matrix elements

$$S_i = \sum_{i=1}^{n} v_{ij} \tag{10}$$

Step 6. Forming the alternative utility function *f(Ki)*. Creating the alternative utility function *f(Ki)* with the following calculation:

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \frac{1-f(K_i^+)}{f(K_i^+)} + \frac{1-f(K_i^-)}{f(K_i^-)}} \tag{11}$$

The utility function concerning the anti-ideal solution is denoted by $f(K_i^-)$, while the utility function concerning the ideal solution is denoted by $f(K_i^+)$.

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-} \tag{12}$$

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-} \tag{13}$$

Step 7. Ranking of alternatives. The alternatives are ranked according to the obtained values, with the best-ranked alternative being the one with the highest value, the next being the second-ranked alternative, and so forth, until the alternative with the lowest value is the worst-ranked alternative.

The ranking of European countries in terms of the TTDI index 2021 is obtained by following the steps of the MARCOS method. Sensitivity analysis determines how much this ranking depends on the auxiliary criteria. This analysis represents the fourth step of this research. This analysis aims to determine how much influence an individual criterion has on evaluating alternatives. The sensitivity analysis will be conducted in two different ways. The first method is to reduce the weight of a particular criterion by a certain percentage (Bakir et al., 2021; Bairagi, 2022; Tešić et al., 2022), in which the weight of the individual criteria will be reduced by 30, 60, and 90%. In this way, only one of the criteria is diminished.

In contrast, the other criteria retain their weights, and the surplus left from the reduction of the individual criterion is distributed evenly among them (Švadlenka et al., 2020; Đukić et al., 2022; Badi & Abdulshahed, 2021). The number of scenarios is determined by the total number of criteria (Stojanović et al., 2022; Puška et al., 2022; Štilić et al., 2022). In this case, there are 17 criteria, each changing three times. In this manner, 51 scenarios are created. The second sensitivity analysis will be carried out to increase each auxiliary criterion by 30, 60, and 90% individually. In contrast, the value of the weights of the other criteria is proportionally reduced by this increase. As a result of the threefold increase in specific criteria, 51 scenarios are also formed.

# 4. Results

The initial decision matrix was created using TTDI data for the observed countries, in this case, the 43 European countries included in this report, as it is considered the first step in both methods used in this research.

**Table 1**
***The initial decision matrix***

| ID | Country | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | … | C17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Albania | 3.82 | 5.60 | 4.72 | 4.69 | 4.73 | 4.60 | 3.10 | 5.33 | 2.67 | 3.31 | … | 3.35 |
| 2 | Armenia | 4.34 | 6.02 | 5.53 | 4.26 | 5.14 | 4.01 | 4.47 | 5.99 | 2.74 | 3.24 | … | 4.55 |
| 3 | Austria | 5.06 | 6.38 | 6.83 | 5.41 | 5.80 | 4.35 | 5.68 | 3.96 | 4.24 | 5.68 | … | 3.77 |
| 4 | Azerbaijan | 4.79 | 5.02 | 5.44 | 5.10 | 5.13 | 3.78 | 2.92 | 5.95 | 2.95 | 4.42 | … | 4.14 |
| 5 | Belgium | 4.76 | 5.37 | 6.39 | 5.30 | 5.86 | 3.55 | 5.81 | 4.08 | 3.97 | 5.45 | … | 4.12 |

**Table 1** ***(continued)***

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Bosnia and Herzegovina | 2.99 | 5.43 | 4.86 | 3.47 | 4.58 | 3.33 | 2.62 | 5.39 | 2.20 | 2.75 | … | 3.33 |
| 7 | Bulgaria | 3.78 | 5.48 | 6.03 | 4.45 | 5.39 | 4.19 | 4.85 | 5.66 | 3.29 | 3.83 | … | 3.77 |
| 8 | Croatia | 3.18 | 5.96 | 5.77 | 4.11 | 5.49 | 4.31 | 4.74 | 4.26 | 3.15 | 4.05 | … | 2.79 |
| 9 | Cyprus | 4.50 | 5.85 | 5.29 | 4.93 | 5.90 | 5.19 | 5.34 | 4.25 | 4.11 | 3.35 | … | 4.11 |
| 10 | Czech Republic | 3.99 | 6.18 | 6.41 | 4.65 | 5.60 | 4.22 | 5.52 | 5.21 | 3.55 | 5.68 | … | 3.71 |
| 11 | Denmark | 5.00 | 6.21 | 5.91 | 5.55 | 6.25 | 3.93 | 5.56 | 3.77 | 4.21 | 5.80 | … | 3.70 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 40 | Switzerland | 5.69 | 6.47 | 6.30 | 6.04 | 6.16 | 4.42 | 5.43 | 2.78 | 4.90 | 6.53 | … | 4.00 |
| 41 | Tajikistan | 3.87 | 5.54 | 4.73 | 4.06 | 3.53 | 3.43 | 2.17 | 5.78 | 2.28 | 3.32 | … | 4.37 |
| 42 | Turkey | 3.84 | 4.77 | 4.79 | 4.38 | 5.17 | 4.43 | 3.36 | 6.01 | 5.01 | 3.99 | … | 3.51 |
| 43 | United Kingdom | 4.91 | 5.64 | 5.94 | 5.05 | 5.95 | 3.90 | 5.67 | 2.77 | 5.29 | 5.29 | … | 4.40 |

Since this ranking of the alternatives requires knowing the weight values of the criterion, these weights were first computed using the MEREC method. The MEREC method begins with creating the initial decision matrix (Table 1). The initial decision matrix's normalization represents the MEREC method's second step. Even though to apply normalization for benefit criteria to all criteria, the values for each criterion should be as high as possible, the uniqueness of this approach lies in the way that Expression 1 was applied after transforming all criteria during normalization into minimum criteria, or Cost criteria.

**Table 2**
***Normalised decision matrix***

| ID | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.78 | 0.85 | 1.00 | 0.74 | 0.75 | 0.68 | 0.70 | 0.52 | 0.80 | 0.81 | 0.47 | 0.60 | 0.86 | 0.70 | 0.79 | 0.79 | 0.83 |
| 2 | 0.69 | 0.79 | 0.85 | 0.82 | 0.69 | 0.78 | 0.48 | 0.46 | 0.78 | 0.83 | 0.48 | 0.85 | 0.77 | 0.74 | 0.89 | 0.79 | 0.61 |
| 3 | 0.59 | 0.75 | 0.69 | 0.64 | 0.61 | 0.72 | 0.38 | 0.70 | 0.50 | 0.47 | 0.30 | 0.43 | 0.46 | 0.34 | 0.68 | 0.62 | 0.74 |
| 4 | 0.62 | 0.95 | 0.87 | 0.68 | 0.69 | 0.83 | 0.74 | 0.47 | 0.72 | 0.61 | 0.70 | 0.77 | 0.50 | 0.69 | 0.84 | 0.78 | 0.67 |
| 5 | 0.63 | 0.89 | 0.74 | 0.66 | 0.60 | 0.88 | 0.37 | 0.68 | 0.54 | 0.49 | 0.44 | 0.66 | 0.43 | 0.34 | 0.79 | 0.66 | 0.68 |
| 6 | 1.00 | 0.88 | 0.97 | 1.00 | 0.77 | 0.94 | 0.83 | 0.51 | 0.97 | 0.97 | 0.51 | 0.74 | 0.85 | 0.72 | 1.00 | 0.84 | 0.84 |
| 7 | 0.79 | 0.87 | 0.78 | 0.78 | 0.65 | 0.75 | 0.45 | 0.49 | 0.65 | 0.70 | 0.37 | 0.45 | 0.56 | 0.51 | 0.76 | 0.77 | 0.74 |
| 8 | 0.94 | 0.80 | 0.82 | 0.84 | 0.64 | 0.73 | 0.46 | 0.65 | 0.68 | 0.66 | 0.28 | 0.35 | 0.55 | 0.59 | 0.78 | 0.72 | 1.00 |
| 9 | 0.66 | 0.82 | 0.89 | 0.70 | 0.60 | 0.60 | 0.41 | 0.65 | 0.52 | 0.80 | 0.32 | 0.73 | 0.73 | 0.38 | 0.82 | 0.69 | 0.68 |
| 10 | 0.75 | 0.77 | 0.74 | 0.75 | 0.63 | 0.74 | 0.39 | 0.53 | 0.60 | 0.47 | 0.41 | 0.62 | 0.55 | 0.45 | 0.77 | 0.63 | 0.75 |
| 11 | 0.60 | 0.77 | 0.80 | 0.63 | 0.56 | 0.80 | 0.39 | 0.73 | 0.51 | 0.46 | 0.38 | 0.46 | 0.57 | 0.33 | 0.69 | 0.60 | 0.76 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 40 | 0.53 | 0.74 | 0.75 | 0.57 | 0.57 | 0.71 | 0.40 | 1.00 | 0.44 | 0.41 | 0.34 | 0.42 | 0.53 | 0.24 | 0.67 | 0.65 | 0.70 |
| 41 | 0.77 | 0.86 | 1.00 | 0.86 | 1.00 | 0.91 | 1.00 | 0.48 | 0.94 | 0.81 | 1.00 | 0.58 | 0.78 | 1.00 | 0.87 | 1.00 | 0.64 |
| 42 | 0.78 | 1.00 | 0.99 | 0.79 | 0.68 | 0.71 | 0.65 | 0.46 | 0.43 | 0.67 | 0.43 | 0.45 | 0.35 | 0.28 | 0.97 | 1.00 | 0.79 |
| 43 | 0.61 | 0.85 | 0.80 | 0.69 | 0.59 | 0.80 | 0.38 | 1.00 | 0.40 | 0.51 | 0.36 | 0.35 | 0.29 | 0.20 | 0.71 | 0.70 | 0.64 |

After creating the normalized initial decision matrix, the total performances of the alternatives were computed (Expression 2). The total absolute value of the natural logarithm (ln) was first calculated for this step. This value was then divided by the total number of criteria, the number one (1) was added to the result, and the natural logarithm (ln) was recalculated from those values. The value of the total performance of the alternatives (Si) was thus formed. The value of the alternatives' effects on each criterion (Expression 3) was calculated similarly, with the criterion for which this effect is calculated excluded. The sum of deviations from absolute values was calculated in the following step in this method (Table 3). This step calculated the total absolute deviation between the values of the alternatives' overall performances and their effects (Expression 4). The criteria weights were then calculated based on the sum of deviations from the absolute difference (Expression 5). The criteria weights were established in this manner (Table

3). According to the results, criterion C11 (Tourist Service Infrastructure) received the most weight and is regarded as the most critical TTDI criterion. Criterion C3 (Health and Hygiene) received the least weight, and the results indicate that this criterion is the least important for ranking European countries in terms of TTDI. The rationale behind acquiring these weights pertains to the variance in values exhibited by specific criteria. Consequently, criterion C11 carries the highest weight due to its substantial dispersion of values, ascertaining the relative significance of criteria concerning TTDI and recognizing that not all criteria hold equal weight in the assessment.

**Table 3**
***Criteria weights obtained using the MEREC method***

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $E_j$ | 0.59 | 0.33 | 0.32 | 0.52 | 0.77 | 0.47 | 1.30 | 0.95 | 0.81 | 0.81 | 1.53 | 1.08 | 0.99 | 1.37 | 0.41 | 0.58 | 1.13 |
| $w_j$ | 0.04 | 0.02 | 0.02 | 0.04 | 0.06 | 0.03 | 0.09 | 0.07 | 0.06 | 0.06 | 0.11 | 0.08 | 0.07 | 0.10 | 0.03 | 0.04 | 0.08 |

Following the computation of the criteria weights, the MARCOS method was used to determine the ranking of European countries based on the TTDI. The first step of this method, like the MEREC method, was the creation of the initial decision matrix (Table 1). The initial decision-making matrix was then expanded to include ideal and anti-ideal solutions. The perfect solution represented the highest values of the alternatives based on specific criteria. In contrast, the anti-ideal solution represented the lowest values of the options based on the same criteria. The following step was to normalize the data from the initial decision matrix (Expression 6). Normalization was applied to all data from the expanded initial decision matrix. The weights obtained by the MEREC method were then used to weight the normalized data. The next step was to determine the utility of the alternatives ($K_i^-$, $K_i^+$) compared to the ideal and anti-ideal solutions (Expression 8 and 9). Following that, the utility function ($f(K_i^-), f(K_i^+)$) was computed using the utility degree's value (Expressions 12 and 13). In this manner, all data for calculating the final value of the alternatives using the MARCOS method were gathered (expression 11). Based on the hybrid MEREC-MARCOS methodology's application, results reveal that Spain has the best TTDI indicators, while Tajikistan - has the worst (Table 4). Furthermore, this analysis demonstrated that Estonia's ranking order declined by seven places, while Turkey's ranking order was most significantly improved, moving up seven positions. The rankings of 16 countries remained unchanged. The variance in rankings can be attributed to the assigned weights for criteria. The most notable divergence occurred with Turkey, showcasing a seven-place improvement compared to other countries. This divergence stems from Turkey exhibiting higher values for criteria that accord greater weight. Similar patterns are observed in Ireland, Croatia, and several other countries, displaying a favourable ranking sequence.

Conversely, Estonia presents an opposing scenario. Despite possessing higher values for specific criteria, these criteria were assigned lower weights, negatively impacting the MEREC-MARCOS ranking methodology. This trend is echoed in other countries, where the sequence produced by these methodologies fares worse than the TTDI report.

**Table 4**
***TTDI-based ranking of European countries using the hybrid MEREC-MARCOS method***

| | $K_i^-$ | $K_i^+$ | $f(K_i^-)$ | $f(K_i^+)$ | $f(K_i)$ | Rank | TTDI`s rank | Difference |
|---|---|---|---|---|---|---|---|---|
| Albania | 1.405 | 0.583 | 0.293 | 0.707 | 0.520 | 38 | 38 | 0 |
| Armenia | 1.509 | 0.626 | 0.293 | 0.707 | 0.558 | 33 | 33 | 0 |
| Austria | 1.912 | 0.794 | 0.293 | 0.707 | 0.708 | 8 | 7 | -1 |
| Azerbaijan | 1.462 | 0.607 | 0.293 | 0.707 | 0.541 | 36 | 34 | -2 |
| Belgium | 1.772 | 0.736 | 0.293 | 0.707 | 0.656 | 14 | 14 | 0 |
| Bosnia and Herzegovina | 1.264 | 0.525 | 0.293 | 0.707 | 0.468 | 42 | 43 | 1 |

**Table 4** ***(continued)***

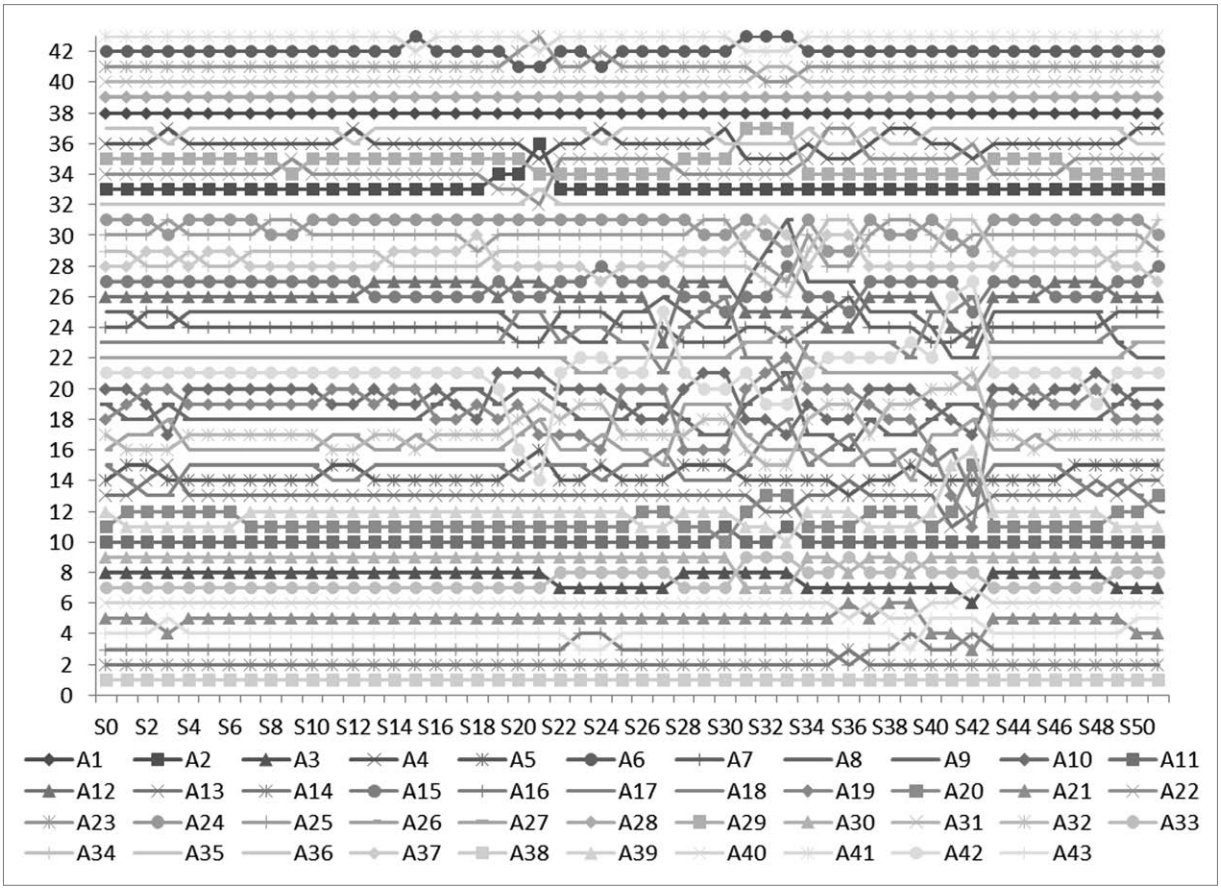
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bulgaria | 1.658 | 0.688 | 0.293 | 0.707 | 0.614 | 24 | 25 | 1 |
| Croatia | 1.653 | 0.686 | 0.293 | 0.707 | 0.612 | 25 | 29 | 4 |
| Cyprus | 1.727 | 0.717 | 0.293 | 0.707 | 0.639 | 19 | 21 | 2 |
| Czech Republic | 1.720 | 0.714 | 0.293 | 0.707 | 0.637 | 20 | 17 | -3 |
| Denmark | 1.825 | 0.758 | 0.293 | 0.707 | 0.675 | 10 | 10 | 0 |
| Estonia | 1.642 | 0.682 | 0.293 | 0.707 | 0.608 | 26 | 19 | -7 |
| Finland | 1.783 | 0.740 | 0.293 | 0.707 | 0.660 | 13 | 11 | -2 |
| France | 2.088 | 0.867 | 0.293 | 0.707 | 0.773 | 2 | 2 | 0 |
| Georgia | 1.638 | 0.680 | 0.293 | 0.707 | 0.606 | 27 | 27 | 0 |
| Germany | 2.038 | 0.846 | 0.293 | 0.707 | 0.754 | 3 | 3 | 0 |
| Greece | 1.766 | 0.733 | 0.293 | 0.707 | 0.653 | 15 | 18 | 3 |
| Hungary | 1.665 | 0.691 | 0.293 | 0.707 | 0.616 | 23 | 23 | 0 |
| Iceland | 1.727 | 0.717 | 0.293 | 0.707 | 0.639 | 18 | 15 | -3 |
| Ireland | 1.803 | 0.748 | 0.293 | 0.707 | 0.667 | 11 | 16 | 5 |
| Italy | 2.014 | 0.836 | 0.293 | 0.707 | 0.745 | 5 | 6 | 1 |
| Kazakhstan | 1.483 | 0.616 | 0.293 | 0.707 | 0.549 | 34 | 35 | 1 |
| Kyrgyz Republic | 1.279 | 0.531 | 0.293 | 0.707 | 0.474 | 41 | 41 | 0 |
| Latvia | 1.590 | 0.660 | 0.293 | 0.707 | 0.588 | 31 | 30 | -1 |
| Lithuania | 1.592 | 0.661 | 0.293 | 0.707 | 0.589 | 30 | 26 | -4 |
| Luxembourg | 1.744 | 0.724 | 0.293 | 0.707 | 0.645 | 16 | 13 | -3 |
| Malta | 1.677 | 0.696 | 0.293 | 0.707 | 0.621 | 22 | 22 | 0 |
| Moldova | 1.336 | 0.555 | 0.293 | 0.707 | 0.494 | 39 | 39 | 0 |
| Montenegro | 1.482 | 0.615 | 0.293 | 0.707 | 0.548 | 35 | 36 | 1 |
| Netherlands | 1.891 | 0.785 | 0.293 | 0.707 | 0.700 | 9 | 8 | -1 |
| North Macedonia | 1.310 | 0.544 | 0.293 | 0.707 | 0.485 | 40 | 40 | 0 |
| Poland | 1.737 | 0.721 | 0.293 | 0.707 | 0.643 | 17 | 20 | 3 |
| Portugal | 1.913 | 0.794 | 0.293 | 0.707 | 0.708 | 7 | 9 | 2 |
| Romania | 1.605 | 0.666 | 0.293 | 0.707 | 0.594 | 29 | 31 | 2 |
| Serbia | 1.452 | 0.603 | 0.293 | 0.707 | 0.537 | 37 | 37 | 0 |
| Slovak Republic | 1.545 | 0.642 | 0.293 | 0.707 | 0.572 | 32 | 32 | 0 |
| Slovenia | 1.607 | 0.667 | 0.293 | 0.707 | 0.595 | 28 | 24 | -4 |
| Spain | 2.120 | 0.880 | 0.293 | 0.707 | 0.784 | 1 | 1 | 0 |
| Sweden | 1.802 | 0.748 | 0.293 | 0.707 | 0.667 | 12 | 12 | 0 |
| Switzerland | 1.961 | 0.814 | 0.293 | 0.707 | 0.726 | 6 | 4 | -2 |
| Tajikistan | 1.245 | 0.517 | 0.293 | 0.707 | 0.461 | 43 | 42 | -1 |
| Turkey | 1.698 | 0.705 | 0.293 | 0.707 | 0.628 | 21 | 28 | 7 |
| United Kingdom | 2.025 | 0.841 | 0.293 | 0.707 | 0.749 | 4 | 5 | 1 |

To determine how sensitive the ranking of alternatives is to change the weight of the criteria, a sensitivity analysis was conducted (Ali et al., 2021; Nassar et al., 2022; Ashraf et al., 2022; Karamaşa et al., 2021; Arvanitis et al., 2021). There were two approaches to this sensitivity analysis. First, the weights assigned to each criterion were reduced by 30, 60, and 90%. It was noted how this change in the weights of the individual criteria affected the ranking order—given that 17 criteria were used and that the weight of each was reduced three times, resulting in 51 scenarios (figure 2). The following findings from this sensitivity analysis demonstrated that Spain came ahead among all 51 scenarios regarding country rankings. France dropped to third place in one scenario, while Germany rose to second place.

Consequently, France had better indicators than Germany for criterion C11, and Germany outperformed France when the weight assigned to this criterion was reduced by 90%. The rationale for all the ranking adjustments is that a country will be ranked lower if it has better indicators for a particular criterion and its

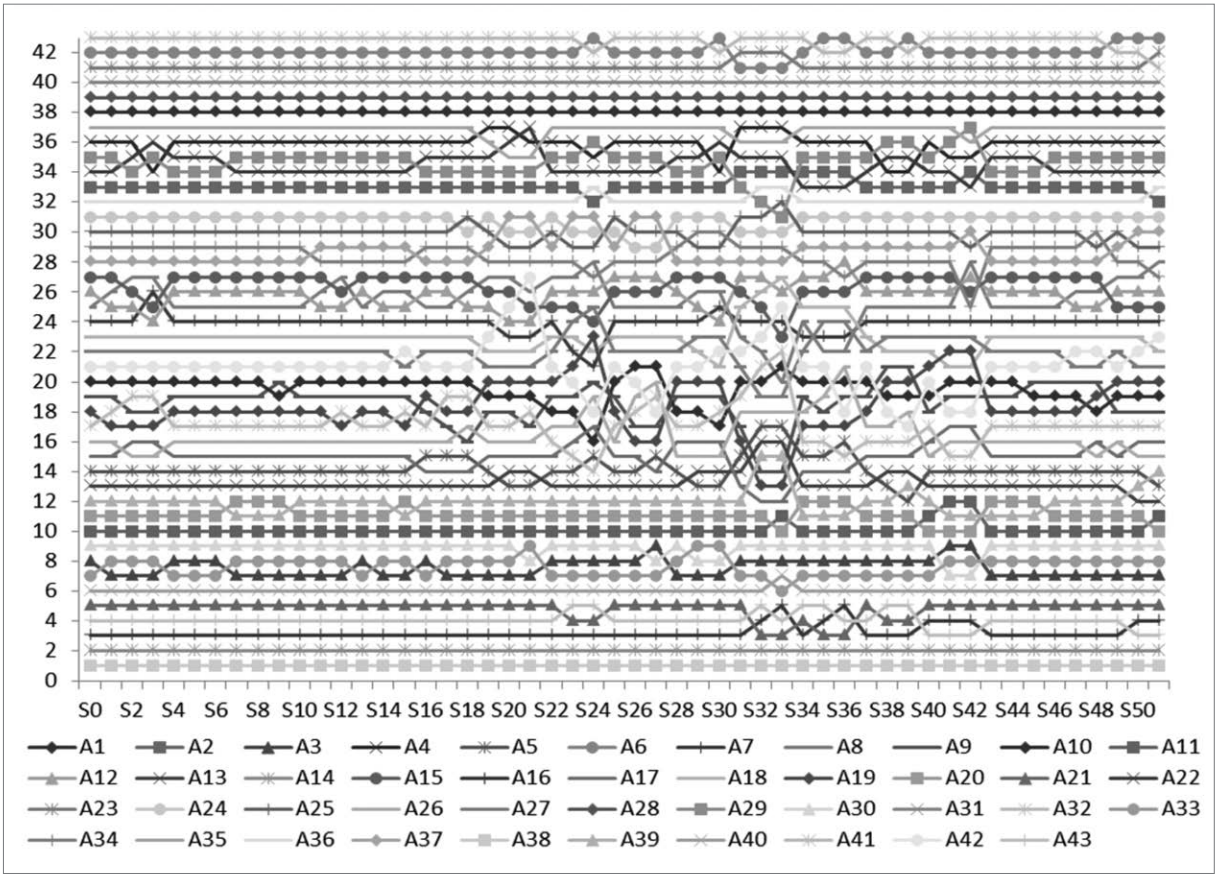
weight is decreased. This holds for the last and penultimate ranked countries, making Bosnia and Herzegovina the worst-ranked European country according to TTDI in four scenarios. At the same time, North Macedonia was the worst-ranked country in one scenario. The most adjustments in ranking order were observed for countries ranked from 10th to 20th place, and even more significant adjustments in ranking order were observed when criteria C13 and C14 were observed.

**Figure 2**
***Sensitivity analysis - Weight reduction***




The weights for each criterion in the second sensitivity analysis were increased by 30, 60, and 90% since 17 criteria created 51 scenarios in this analysis (figure 3). Spain came in first in all scenarios, with France coming in second. In four scenarios, Switzerland came in third instead of Germany, followed by Italy outranking Germany in one of the scenarios. Unlike the previous sensitivity analysis, if the weight of the criterion increases, the ranking adjustments, indicating that the country that would improve the ranking has better indicators in that criterion than the country that it overtook in the ranking. In this sensitivity analysis, Bosnia and Herzegovina ranked eight times as the worst in terms of TTDI, while Turkmenistan was better for those scenarios. The most significant changes in these countries' rankings were observed between positions 13 and 25, with numerous modifications in country rankings.

**Figure 3**
***Sensitivity analysis - Weight increment***




These sensitivity analyses revealed that Spain has the best TTDI indicators out of all the European countries, and in no scenario did it rank lower, proving that Spain has the best TTDI indicators. Only Moldova and Albania, among the others, maintained their positions, but they were otherwise ranked 38th and 39th, respectively. Therefore, to improve its ranking, a country must consider the countries ranked higher and contrast their rankings. To perform better in comparison to the higher-ranking countries, it is necessary to improve those specific indicators where they are weaker. As a result, these findings may enhance each country's performance on the TTDI and increase the number of tourists it draws.

# 5. Discussion

The TTDI developed by the WEF represents the index that measures a country's competitiveness in four categories of tourism criteria: Enabling Environment, Travel and Tourism Policy and Enabling, Infrastructure, Travel and Tourism Demand Drivers, and Travel and Tourism Sustainability. All requirements are each broken down into three sub-criteria, except for the first -Enabling Environment- criterion, which is further divided into five sub-criteria. In this way, the WEF prioritizes this criterion over other criteria, as it has more sub-criteria and contributes more to the final ranking of countries. This is because the average value of these criteria across all countries determines the WEF's TTDI ranking order. Unlike papers by Liu et al. (2021), where weights were assigned first to the main TTDI criteria and then to the sub-criteria, in this paper, the 17 sub-criteria are examined collectively. As a result, each of these sub-criteria was given the same consideration.

Using the MEREC method, the weights for these sub-criteria were determined. The difference between this method and others is that it uses cost normalization, which reduces all criteria values to the minimum. However, Puška et al. (2022) used this method in conjunction with benefit normalization to minimise the effect of normalization when comparing weights obtained by other methods. In this manner, both approaches can be applied to the MEREC method. This method indicated that sub-criterion C11 is the most important, followed by criterion C14, with sub-criterion C3 receiving the least weight. The results of this method revealed that the Enabling Environment sub-criteria have the lowest average weight, even though this group of criteria was given the most weight according to TTDI and is the only one consisting of the five sub-criteria. The average weights for the Travel and Tourism Demand Drivers group sub-criteria were the highest. These sub-criteria received an average weight of 2.28 times greater than the Enabling Environment group of criteria. When viewed as a whole, the three sub-criteria of the Travel and Tourism Demand Drivers group are more important for 36% than the five sub-criteria of the Enabling Environment group.

The rankings of the European countries were determined using the weights determined by the MEREC method and the MARCOS method's ranking. The ranking of European countries in terms of TTDI deviates from the original ranking due to the weights assigned to the obtained sub-criteria. However, using Spearman's correlation coefficient, the results show that this difference is insignificant, with r = .981. The most significant difference in ranking was observed for Turkey, where this country improved by seven places, while Estonia's ranking deteriorated by seven. This analysis revealed that 16 countries maintained their rankings, and as a result, there was no change in the rankings for those 16 countries.

The sensitivity analysis results demonstrated how sensitive each country is to changes in the sub-criteria weights. The sub-weight criteria in the initial sensitivity analysis were decreased by 30, 60, and 90%. This analysis demonstrated how the ranking order changes in response to changes in the sub-criteria weights (Andrejić & Pajić, 2023). A country's ranking could be impacted negatively when another country had better indicators following the adjusting criterion weights. In the second sensitivity analysis, the value of a sub-criterion was raised by 30, 60, and 90%. In three scenarios, a better ranking order was awarded to the country with a better indicator for specific sub-criteria in this analysis. Each country could use this sensitivity analysis to determine which sub-criteria it is susceptible to and which sub-criteria have had the most significant negative or positive effects on ranking changes. Additionally, this analysis demonstrated that Spain is the best in every scenario, showing that it has the highest value in most sub-criteria compared to other European countries. Furthermore, these analyses revealed that Turkmenistan, Bosnia, and Herzegovina have the lowest TTDI indicators.

# 6. Conclusion

The TTDI application aims to demonstrate the level of international tourism competition among different countries. The better the index's indicators, the more competitive the country's tourism is. The analysis of the TTDI indicators revealed that if the sub-criteria are not given equal weight, the ranking order of countries changes. According to this analysis, Spain has the best indicators of any European country, while Turkmenistan has the worst. The sensitivity analysis supported these findings.

The research's limitations stem from using many nations-43 in total, in which the TTDI contained data. The results are somewhat perplexing because of the many countries in the sensitivity analysis. To gather more in-depth information, future research should focus on specific European regions and only those countries that are located there. The results of these research studies would support the countries in improving tourism potential compared to neighbouring countries, as individual countries do not have the same opportunities, level of development, or investment for tourism possibilities.

However, the purpose of this study was to demonstrate that not all criteria could be viewed in the same way since each country has unique tourism characteristics. As a result, understanding the unique characteristics

of individual countries is essential if they are to develop their tourism industries competitively with others, and research methodology and results can help them improve their countries' TTDI rankings. Furthermore, these results demonstrated that the MCDM methodologies could be used to rank countries in terms of tourism potential.

The outcomes of this research offer actionable recommendations for the WEF regarding the equitable consideration of criteria in TTDI formulation. It is imperative to discern which criteria should hold greater weight, thereby enhancing the precision of tourism development within the observed countries. Recognizing the disparities in natural conditions among nations underscores the need for tailored approaches to evaluate the utilization of existing potentials and identify untapped opportunities. Tailored strategies are crucial for targeted interventions to foster tourism development in these diverse contexts. Consequently, recalibration of TTDI-based country rankings is necessary to depict tourism applications within these nations accurately.

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