UDC:

DOI: 10.5937/menhottur2600011R

Received: 13 April 2026
Revised: 28 May 2026
Accepted: 9 July 2026
Published online: 22 July 2026

Tourism performances through the lens of the circular economy framework: Evidence from EU countries

Žarko Rađenović[1], Jelena Dimovski[1*], Valdas Dambrava[2]

[1] University of Niš, Innovation Center, Niš, Serbia
[2] Vilnius Kolegija, Faculty of Business Management, Vilnius, Lithuania

Abstract

Purpose – Tourism, based mainly on the linear model, is a sector that makes a crucial contribution to economic growth but still has an undeniable negative impact on the environment. Thus, its role in the transition to the circular economy (CE) has been recognized as an initiative consistent with the sustainable development goals, mitigating the environmental externalities of tourism and further contributing to economic development. The authors aim to examine the application of CE principles in the tourism sector and assess their environmental impact. **Methodology –** Employing the CRITIC, MOORA, ARAS, and CoCoSo methods, the authors analyze the ranking position of the EU-27 countries, examining the combined tourism and CE indicators (recycling rates, circular material use rate, waste per capita, resource productivity, international tourism expenditures, receipts, arrivals and departures, travel item receipts, tourism employment, and tourism contribution to GDP). **Findings –** The research findings reveal that countries which harmonize tourism growth with higher levels of circularity achieve systematically better overall performance than those that rely mainly on tourism flows. **Implications –** The study highlights the complexity of the relationship between these two sectors, underscoring the need for intersectoral coordination and long-term policies to mitigate the negative environmental impact of tourism.

Keywords: tourism, circular economy, sustainable development, EU, environment
JEL classification: Q01, Q50, Z30

Performanse turizma kroz prizmu cirkularne ekonomije: Analiza zemalja Evropske unije

Sažetak

Svrha – Turizam, kao sektor prvenstveno zasnovan na linearnom modelu, daje svoj nedvosmislen doprinos ekonomskom rastu, istovremeno kreirajući negativan uticaj na životnu sredinu. Stoga je uloga turizma u tranziciji ka cirkularnoj ekonomiji (CE) prepoznata kao bitna inicijativa koja je u skladu sa ciljevima održivog razvoja, doprinoseći ublažavanju ekoloških eksternalija turizma i stvarajući dodatni pozitivan podsticaj ekonomskom razvoju. Autori u radu nastoje da daju pregled postojeće literature o primeni principa CE u turizmu,

* Corresponding author: jelena.dimovski@icun.ni.ac.rs

ali i sagledaju njegov uticaj na životnu sredinu. **Metodologija** – Upotrebom CRITIC, MOORA, ARAS i CoCoSo metoda, autori analiziraju pozicioniranje EU-27 zemalja kombinovanjem odgovarajućih indikatora turizma i CE (stopa recikliranja; stopa upotrebe cirkularnih materijala; otpad po stanovniku; produktivnost resursa; rashodi, prihodi, dolasci i odlasci u međunarodnom turizmu; troškovi putovanja; zaposleni u turizmu; i učešće turizma u BDP). **Rezultati** – Rezultati istraživanja potvrđuju da zemlje koje balansiraju razvoj turizma i visok nivo cirkularnosti ostvaruju bolje ukupne performanse u odnosu na one koje se u razvoju oslanjaju samo na tokove turizma. **Implikacije** – Istraživanje ističe složenost odnosa između turizma i CE, ističući potrebu za međusektorskom koordinacijom i dugoročnim politikama i strategijama koje će voditi ublažavanju negativnog uticaja turizma na životnu sredinu.

Ključne reči: turizam, cirkularna ekonomija, održivi razvoj, EU, životna sredina
JEL klasifikacija: Q01, Q50, Z30

1. Introduction

Tourism is a powerhouse of the global economy, facilitating employment opportunities, enhancing economic growth, and promoting the richness and diversity of cultural heritage worldwide. As one of the most developed sectors, travel and tourism are projected to create 4.5 million new jobs in the European Union (EU) by 2035, bringing the total to more than 30 million (World Travel & Tourism Council, 2026). Its contribution to EU GDP is forecast to rise from 1.9 trillion in 2025 to nearly 2.3 trillion by 2035, approaching 11% of the EU's economic share during the same period. This will further strengthen tourism's crucial economic and social role in the EU, making it one of the most strategically significant industries in the region (Isik et al., 2018; Radivojević et al., 2023).

However, viewed through an environmental lens, tourism is a highly energy- and water-intensive industry that generates significant waste and wastewater, ranking among the largest contributors to global greenhouse gas emissions (Caponi, 2022; Kaszás et al., 2022; Zorpas et al., 2021). More specifically, greenhouse gas emissions from tourism account for about 8% of global emissions and could reach 25% by 2050 (Peeters et al., 2024). Also, water use and waste generation per tourist in the EU are twice those of the average EU citizen (Li et al., 2024; Rodríguez et al., 2020). As the world's population grows, tourism's environmental impact will increase, underscoring the urgency of coordinated strategies that align tourism development with environmental sustainability. Achieving sustainability in tourism thus depends on effectively balancing economic gains and ecological conservation. In this context, the circular economy (CE) in tourism has emerged as a reasonable response and a vital policy framework.

The CE concept, focused on maximizing resource efficiency and minimizing waste through recycling and reuse, supports the aligment of tourism activities with sustainable goals (Kaszás et al., 2020) and improves sustainability and quality within the sector. While some authors recognize the critical role tourism has in reaching sustainable development goals (Ghisellini et al., 2016; Khizar et al., 2023; Rasoolimanesh et al., 2023), considering at the same time its environmental, social, and economic implications, there is also a need to preserve quality tourist offers and memorable experiences for visitors with significant involvement of hosting communities in the design of tourism services (Strippoli et al., 2024).

Although interest in sustainability is increasing, the implementation of circular economy principles within the tourism sector remains insufficiently examined, particularly in empirical studies. Environmentally friendly practices may not only mitigate environmental

degradation but also increase the attractiveness of destinations to environmentally aware travelers, thereby enhancing their competitiveness (Stanišić et al., 2022; Vávrová et al., 2025). Thus, this study aims to investigate the relationship between CE indicators, specifically, recycling rates, circular material use rate, waste per capita, resource productivity, and tourism indicators reflected in the international tourism expenditures, international tourism receipts, international tourism arrivals, international tourism departures, travel item receipts, tourism employment, and tourism contribution to GDP. The authors analyze panel data for the 27 EU member countries over 2021-2025, and hypothesize that tourist destinations committed to sustainable tourism will attract a greater number of international tourists. Providing data analysis for EU member countries on the link between the CE and tourism, the study brings valuable insights for policymakers and relevant stakeholders interested in implementing the European Green Deal and the EU's Circular Economy Action Plan. Following the main research goal, the study aims to answer the following research questions:

RQ1. How does the integration of CE indicators reshape the relative importance of traditional tourism performance metrics in determining the overall positioning of EU-27 countries?

RQ2. To what extent do disparities in circular economy development explain structural differences between tourism-intensive and sustainability-oriented economies within the EU?

The rest of the paper is structured as follows: Section 2 provides a theoretical background of the CE concept and its application in tourism, Section 3 presents the methodology and data employed in the study, Section 4 discusses the research results, and Section 5 offers concluding remarks, followed by recommendations and research limitations.

2. Theoretical background: Circular economy concept and its link to tourism

The sustainable economic growth grounded in a traditional linear production model is facing limitations due to scarce resources and excessive waste, prompting the development of a new economic model that focuses on a sustainable, renewable system to advance resource efficiency, reduce waste, and mitigate environmental externalities. The circular economy (CE), as an antithesis of the linear model, is closely linked to sustainable development and, as its prerequisite, directly contributes to the country's sustainability (Arruda et al., 2021; Geissdoerfer et al., 2017; Suarez-Eiroa et al., 2019). In contrast to the linear model, which relies on a "take, make, waste" approach, CE emphasizes the importance of recycling and reuse, thereby minimizing waste and leading to a more sustainable economy (Ekins et al., 2019). As a concept rooted in environmental economics and integrated in sustainable development, the circular economy (CE) has been defined by various scholars. Broadly, the circular economy is an economic system that replaces the traditional "end-of-life" approach with strategies focused on reusing, recycling, and reducing material use in both production and consumption (Kirchherr et al., 2017). This system operates at multiple levels (micro, meso, and macro) and seeks to advance sustainable development, as reflected in environmental quality, economic progress, and social equity for both current and future generations. The Ellen MacArthur Foundation (2013) further expands this definition, emphasizing that CE necessitatesrequires the use of renewable energy, the elimination of toxic chemicals, and waste reduction through the eco-design of materials, products, and sustainable business models. Some authors conceptualize the circular economy as a means of achieving economic progress through the ecological circulation of natural materials, adherence to ecological principles, and responsible utilization of natural resources to fulfill

economic objectives (Mansi et al., 2025), or as a production and consumption concept characterized by closed-loop material flows that assimilate environmental externalities linked to virgin resource extraction and waste generation (Sauvé et al., 2016). This model is considered the opposite of the linear economy and predicts no waste but efficient use of all resources (Sharma et al., 2025). While Morseletto (2020) introduced the comprehensive 10R framework of CE principles, which includes refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover, the most commonly used are the 3R or 4R models. The 3R concept, emphasizing - reuse, reduce, and recycle - remains the most prevalent. Some authors extend this model to 4R by incorporating recovery, or further expand it by adding the rethinking principle (Kiaušienė et al., 2024).

The application of the CE concept to the tourism sector has only recently attracted greater scholarly attention, and despite its unambiguous contribution to sustainable tourism and broader sustainable development, the literature on this topic remains limited. However, interest in exploring CE in the tourism sector stems from the need to address environmental burdens arising from the limited application of CE principles. Mass tourism and resource-intensive activities make the tourism sector a major contributor to resource exhaustion and environmental deterioration (Rodríguez-Antón & Alonso-Almeida, 2019). According to Sharma et al. (2025), urban areas worldwide are the largest users of natural resources (60–80%) and the largest generators of greenhouse gas emissions (75%), while suffering from climate change, resource degradation, and high levels of waste. The prediction of the UN Tourism (2026) that 68% of the global population will inhabit urban areas by 2050 points out the urgency of finding sustainable solutions.

The transition to a circular economy aims to encourage the tourism sector to build a more resilient tourism ecosystem that benefits all its stakeholders without exceeding environmental and social capacities (Sorin & Einarsson, 2020). Researchers in the tourism and travel sector have found that the most commonly adopted CE principle in tourism is the 3Rs: "reduce-reuse-recycle", which aims to promote eco-friendly, low-energy products while considering pollution control, clean and green production, the use of renewable resources, and waste management (Kiaušienė et al., 2024). These results underscore the importance of adopting practices that reduce waste, promote waste avoidance, optimize resource use, empower the tourism value chain and increase recycling rates to achieve a more sustainable, environmentally friendly tourism sector. Integrating these CE principles into the tourism sector encourages innovation, the development of sustainable business models, and overall benefits of green jobs for tourists and local communities (UNWTO, 2021). According to Ekins et al. (2019), circular tourism involves: 1) sustainable tforms of mobility, such as eco-friendly transport, sharing economy, 2) locally produced food, 3) shared accommodation in local communities, and 4) the reduction of single-use products in accommodations.

While research on CE in tourism has made some progress over time, thanks to the combined efforts of various institutions, organizations, scholars, and other relevant stakeholders, practical application in tourism and travel activities remains limited, as consumers of these activities are not sufficiently aware of the existence of CE principles, emphasizing the importance of the social dimension as well (Sharma et al., 2025). The primary benefit of applying CE in tourism is the reduction of environmental burdens, while highlighting the importance of respecting sustainable principles (Manniche et al., 2017; Özdemir & Tosun, 2023; Vatansever et al., 2021). Although CE applications in the tourism sector can be diverse, some authors indicate that successful CE strategies can be directly linked to substantial waste reduction, greater use of renewable energy, and the availability of eco-products and services, while maintaining a high level of traveler experience (Florido et al., 2019; Peeters & Landré, 2012). One of the proposed strategies is to limit single-use products and transition to reusable products or suitable alternatives across different tourist facilities. In

line with this, the hotel industry is already obliged to work on removing single-use plastic essentials and substituting them with refillable dispensers (WTTC, 2026). Finding solutions to plastic waste and pollution can more effectively support the implementation of CE in tourism by reducing unnecessary plastic use through reuse and strengthening recycling practices. In addition, tourism and travel operators can invest more in renewable energy sources and eco-friendly technologies that conserve water and other natural resources, as well as in recycling organic materials for different purposes or in reusing water for irrigation (Ellen MacArthur Foundation, 2013). The introduction of sustainable food strategies contributes to the CE in the tourism sector, as food is the starting point of the value chain, with sustainable procurement of local and bio resources, healthy meal menus, and food waste management (UNWTO, 2021). The benefits of this closed-loop system are reflected not only in reduced waste but also in empowering local economies by generating employment opportunities in the waste management and recycling sectors (Khan et al., 2021). However, UN Tourism (2026) highlights the role of CE in inspiring cooperation among stakeholders, such as local authorities, businesses, and visitors, to develop appropriate strategies and guidelines aligned with sustainable tourism. By meeting CE principles, the tourism sector can achieve sustainable growth that is in balance with the environment and local economies.

3. Materials and methods

The empirical analysis is based on a composite dataset that integrates tourism and CE indicators from internationally recognized statistical sources. Specifically, tourism-related variables were obtained from the World Bank, while circular economy indicators were sourced from Eurostat. These databases ensure methodological consistency, cross-country comparability, and high data reliability, which are essential for multi-criteria decision-making applications (Yazdani et al., 2021). In order to enhance temporal stability and reduce short-term fluctuations, all indicators were aggregated as average values over the period 2021-2025. This approach allows for a more robust representation of structural performance across EU-27 countries, particularly in the context of post-pandemic recovery dynamics that affect both tourism and resource efficiency systems. All indicators were normalized prior to multi-criteria evaluation because the dataset includes variables measured in different units, including monetary indicators, rates, flows, employment, and environmental pressure indicators. For benefit indicators, where higher values represent better performance, minm-max normalization was applied as follows:

$$x'_{ij} = \frac{x_{ij} - min(x_{ij})}{max(x_{ij}) - min(x_{ij})} \quad (1)$$

where i is the country being analyzed, j is the indicator being analyzed, x_{ij} is the original value of country i on indicator j, x'_{ij} is the normalized value of country i on indicator j after transformation to a 0-1 scale, $min\ (x_{ij})$ is the lowest observed value among all countries for indicator j, and $max\ (x_{ij})$ is the highest observed value among all countries for indicator j. For the cost indicator, waste per capita, where lower values represent better performance, reverse min–max normalization was applied. This transformation ensures that all normalized values range from 0 to 1 and that higher normalized values consistently indicate better performance. The cost criterion was therefore treated in a directionally consistent manner across all MCDM methods. Missing observations were handled using a conservative latest-available-value approach. If one or more annual values were missing within the 2021-2025 period, the most recent official observation available from the same source was used. If no reliable value was available for a given indicator and country, the observation was excluded rather than imputed using unsupported assumptions. This procedure avoids artificial inflation or smoothing of country performance and preserves comparability across EU-27 countries. To

ensure reproducibility, the revised manuscript includes an additional appendix table reporting the original country-level values for all indicators before normalization, the normalized values used in the calculations, the indicator type, the data source, the statistical code, and the access date. This addition allows independent verification of the CRITIC weights and the MOORA, ARAS, and CoCoSo rankings. The descriptive statistical analysis (Table 1) indicates that circular economy indicators exhibit greater variability than traditional tourism metrics, reinforcing their stronger discriminative capacity within the particular weighting framework.

Table 1: Descriptive statistics for the analyzed indicators

Code	Indicator	World Bank/ Eurostat code	Type	Mean	Min	Max
C1	International tourism expenditures	st.int.xpnd.cd	Benefit	0.64	0.28	1.00
C2	International tourism receipts	st.int.rcpt.cd	Benefit	0.67	0.30	1.00
C3	International tourism arrivals	st.int.arvl	Benefit	0.69	0.32	1.00
C4	International tourism departures	st.int.arvl	Benefit	0.61	0.29	0.95
C5	Travel item receipts	imf / unwto	Benefit	0.63	0.30	0.98
C6	Tourism contribution to GDP	lfsa_egan22d / tour_lfs1	Benefit	0.66	0.35	0.95
C7	Tourism employment	lfsa_egan22d / tour_lfs1	Benefit	0.65	0.33	0.93
C8	Recycling rate	cei_wm011	Benefit	0.72	0.40	0.95
C9	Circular material use rate	cei_srm030	Benefit	0.70	0.35	0.97
C10	Waste per capita	cei_pc031	Cost	0.58	0.35	0.80
C11	Resource productivity	sdg_08_020	Benefit	0.68	0.38	0.96

Source: Authors' research

The present study (Table 2) employs the CRITIC (Criteria Importance Through Inter-criteria Correlation) method to derive objective weights for a set of tourism and circular economy indicators used to evaluate the relative performance of EU-27 countries. The integration of CRITIC with MOORA (Multi-Objective Optimization by Ratio Analysis), ARAS (Additive Ratio Assessment), and CoCoSo (Combined Compromise Solution) provides a comprehensive and internally consistent decision-making framework that captures both structural and sustainability-related dimensions of economic performance (Rađenović & Rajić, 2024). The application of triangulated, complementary multi-criteria techniques enables a comparative evaluation of ranking outcomes, thereby enhancing the robustness and reliability of assessments of tourism performance and circular economy efficiency across EU-27 countries. Each method applies distinct normalization and aggregation procedures, providing different perspectives on country performance and allowing for cross-validation of results within a unified analytical framework. The weighting of indicators is performed using the CRITIC (CRiteria Importance Through Intercriteria Correlation) method, which provides an objective, data-driven approach to determining the relative importance of each criterion. Unlike subjective approaches such as expert-based weighting or Analytic Hierarchy Process (AHP), CRITIC relies on statistical properties, namely standard deviation and inter-criteria correlation, to capture both the variability and informational independence of indicators. This is particularly relevant in the context of tourism and circular economy systems, where indicators reflect diverse dimensions, including economic performance, resource efficiency, and environmental sustainability (Rađenović & Marjanović, 2020). Within this framework, indicators that exhibit greater variability across countries and lower redundancy with other variables are assigned higher weights as they provide stronger discriminatory power in the evaluation process. In the tourism-circular economy context, this typically results in greater emphasis on indicators such as circular material use rates, recycling performance, and

tourism's contribution to GDP, which vary significantly across EU member states. Conversely, more stable or highly correlated indicators, such as tourism arrivals or expenditures, tend to receive lower weights.

Table 2: Methodological pipeline

Methodological Framework of Study	**Main Elements**
Data Collection & Preprocessing	World Bank – tourism indicators
	Eurostat – circular economy indicators
	Indicator set: C1–C11
	Averaging period: 2021–2025
	Normalization and imputation
Multi-Criteria Evaluation	CRITIC weighting
	MOORA ranking
	ARAS ranking
	CoCoSo ranking

Source: Authors' research

The integration of CRITIC with MOORA, ARAS, and CoCoSo enables the construction of balanced, transparent, and reproducible composite rankings, minimizing methodological bias and supporting more reliable cross-country comparisons in heterogeneous economic and institutional environments (Table 3). Unlike approaches based on subjective weighting, this framework ensures that rankings are driven by objective statistical properties of the data, thereby enhancing transparency and reproducibility.

Table 3: Comparison between applied MCDM methods

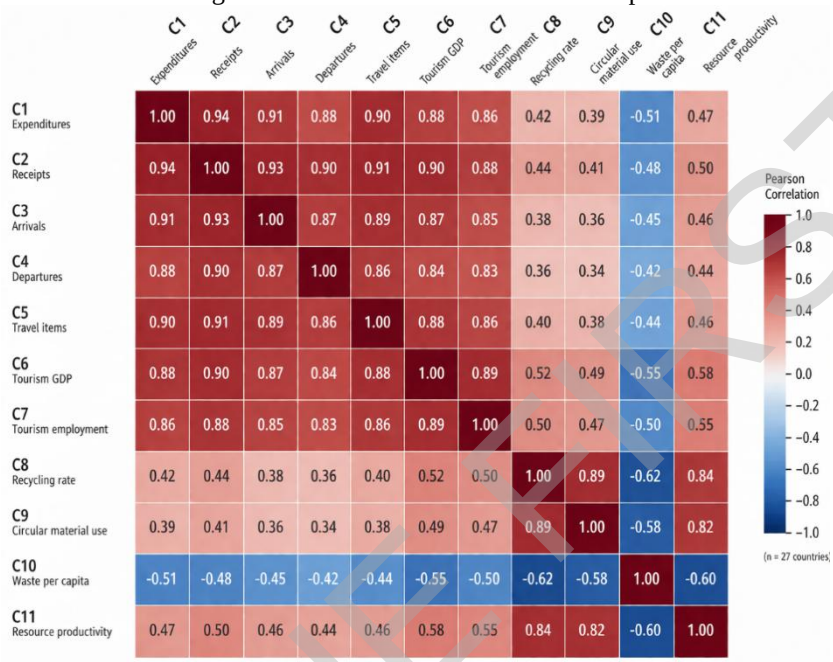
Feature	**CRITIC**	**MOORA**	**ARAS**	**CoCoSo**
Type	Weighting method	Ranking method	Ranking method	Ranking method
Purpose	Objective criteria weighting	Multi-objective ranking	Utility-based ranking	Compromise ranking
Normalization	Min–max	Vector normalization	Ratio normalization	Combined normalization
Aggregation logic	Based on variance & correlation	Benefit–cost difference	Relative utility degree	Additive + multiplicative
Input requirement	Decision matrix	Weighted decision matrix	Weighted decision matrix	Weighted decision matrix
Handling of criteria	Captures conflict between criteria	Separates benefit & cost criteria	Compared to the optimal alternative	Integrates multiple compromise measures
Sensitivity	High (depends on data structure)	Moderate	Moderate	Lower (more stable compromise)
Output	Criteria weights	Ranking scores	Utility degree	Final compromise index
Advantage	Objective, data-driven	Simple and efficient	Intuitive interpretation	High robustness
Limitation	Sensitive to correlations	Less flexible with uncertainty	Depends on the reference alternative	More complex computation

Source: Authors' research

Indicators with high variability and low correlation with other criteria are given greater weights since they provide more unique and discriminative information for decision-making. In this analysis, the CRITIC method is particularly suitable because it ensures a data-driven, unbiased weighting scheme, which is essential when combining diverse areas such as tourism performance and circular economy efficiency (Figure 1). The dataset shows significant intercorrelation among traditional tourism indicators, reflected in international

tourism arrivals, receipts, and expenditures, indicating redundancy within this group. In contrast, circular economy indicators have lower correlations and higher variability, which enhances their informational value within the CRITIC framework (Rađenović & Boshkov, 2023).

Figure 1: Correlation coefficients heatmap



Source: Authors' research

As a result, the weighting scheme naturally emphasizes indicators related to resource efficiency, recycling, and circular material use, without relying on predefined normative preferences. These MCDM methods were selected because they employ different aggregation and normalization techniques, enabling robust comparison of ranking outcomes. MOORA assesses countries by splitting criteria into benefit and cost components and computing a net performance score through vector normalization. Conversely, ARAS applies proportional normalization and compares each alternative with an optimal benchmark, producing a utility score that reflects overall efficiency. CoCoSo combines additive and multiplicative aggregation methods to produce a balanced ranking that accounts for multiple evaluation perspectives. The use of CRITIC reveals a clear structural difference between the two groups of indicators (Do, 2024). Although tourism-related variables are economically important, they display high internal correlations, which diminishes their additional informational value. In contrast, circular economy indicators have a greater influence on the weighting scheme due to their relative independence and wider variation across EU member states. Notably, the higher weights assigned to circular-economy variables arise naturally from the data structure rather than from any imposed sustainability bias (Table 4). This underscores their role as key differentiators in evaluating current economic performance, especially within the EU's shift toward resource-efficient, sustainable growth models (Vranjanac & Rađenović, 2022). To ensure methodological robustness, a supplementary analysis using equal weighting was conducted, yielding generally similar ranking results. This confirms that the country rankings are not artifacts of the weighting method but reflect genuine multidimensional differences among EU economies.

Table 4: Coefficients' weights for the analyzed set of indicators

Criterion	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
Weights	0.072	0.089	0.094	0.068	0.081	0.102	0.091	0.108	0.115	0.087	0.093

Source: Authors' research

4. Results and discussion

The comparative ranking results obtained from MOORA, ARAS, and CoCoSo reveal a highly consistent hierarchical structure across the EU-27, indicating strong methodological robustness of the integrated CRITIC-based framework. The combined evidence on rankings suggests that the transition from volume-based tourism competitiveness to sustainability-adjusted performance is already reshaping the relative positions of EU member states. Countries with more mature circular economy systems gain a clear strategic advantage, while tourism-intensive economies with weaker circular performance face a relative loss in multidimensional competitiveness. Accordingly, the results highlight the growing policy relevance of integrating circular economy measures into tourism development strategies at both national and EU levels. In all three methods, the top-performing countries are the Netherlands, Germany, and France, which systematically combine strong tourism-related performance with advanced circular-economy characteristics (Table 5). Their dominant positions suggest that superior national performance is not determined solely by tourism scale, but rather by the ability to combine economic dynamism with resource efficiency and circular material management. A second notable finding concerns the relative position of Spain and Italy. Although both countries are among the strongest performers in European tourism, their rankings are slightly penalized when circular economy indicators are incorporated. This pattern is especially visible in ARAS and CoCoSo, where the inclusion of recycling, circular material use, and resource productivity moderates the advantage traditionally associated with tourism volume. The result confirms that, within a multidimensional competitiveness framework, high tourism intensity alone is insufficient to secure the highest positions when sustainability-adjusted criteria are considered simultaneously. The middle segment of the ranking is occupied by countries such as Belgium, Austria, Sweden, Denmark, Finland, Portugal, Greece, and Ireland, although their relative ordering varies slightly across methods. This group is analytically important because it reflects distinct development profiles that lead to comparable composite performance. For example, the Nordic countries are characterized by very strong circular economy performance but a more moderate tourism scale. At the same time, Portugal and Greece benefit primarily from tourism specialization, with weaker support for sustainability. Such variation indicates that similar overall rankings may emerge from structurally distinct combinations of strengths and weaknesses. The lower part of the ranking is dominated by Bulgaria, Romania, and Luxembourg, with Luxembourg consistently placed last in all three methods. In the case of Romania and Bulgaria, the weak results reflect comparatively low performance in both tourism and circular economy dimensions, suggesting structural constraints across multiple criteria. Luxembourg represents a special case: despite its high-income level and favorable productivity indicators, its comparatively limited tourism scale reduces its composite performance within the selected indicator system. This finding illustrates the importance of dimensional balance in multi-criteria assessments and confirms that high performance in one domain cannot fully compensate for persistent weaknesses in another.

Table 5: Ranking output from the three MCDM methods

Country	**MOORA Optimization**	**MOORA Rank**	**ARAS (U_i)**	**ARAS Rank**	**CoCoSo (K)**	**CoCoSo Rank**
Netherlands	0.842	2	0.912	1	0.912	1
Germany	0.851	1	0.905	2	0.905	2
France	0.823	3	0.893	3	0.893	3
Spain	0.801	4	0.857	5	0.875	4
Italy	0.792	5	0.874	4	0.869	5
Belgium	0.756	6	0.843	6	0.842	6
Austria	0.731	7	0.826	7	0.825	7
Sweden	0.708	8	0.800	9	0.812	8
Denmark	0.699	9	0.808	8	0.806	9
Finland	0.684	10	0.793	10	0.798	10
Portugal	0.641	11	0.760	11	0.765	11
Greece	0.612	13	0.748	12	0.752	12
Ireland	0.618	12	0.740	13	0.741	13
Poland	0.579	14	0.709	14	0.710	14
Czechia	0.566	15	0.701	15	0.702	15
Hungary	0.548	16	0.689	16	0.688	16
Croatia	0.529	17	0.675	17	0.675	17
Slovakia	0.514	18	0.663	18	0.662	18
Slovenia	0.502	19	0.651	19	0.651	19
Lithuania	0.481	20	0.630	20	0.630	20
Latvia	0.456	22	0.621	21	0.621	21
Estonia	0.462	21	0.615	22	0.615	22
Cyprus	0.441	23	0.602	23	0.602	23
Malta	0.433	24	0.598	24	0.598	24
Bulgaria	0.398	25	0.570	25	0.570	25
Romania	0.381	26	0.552	26	0.552	26
Luxembourg	0.366	27	0.540	27	0.540	27

Source: Authors' research

From a methodological perspective, the close correspondence among rankings obtained through MOORA, ARAS, and CoCoSo strengthens the credibility of the results. Minor positional exchanges, such as between Sweden and Denmark or Greece and Ireland, are expected given the differences in normalization and aggregation logic across methods. However, the stability of both the top and bottom segments indicates that the observed hierarchy is not an artifact of a single technique but rather reflects underlying multidimensional differences across countries. This convergence is particularly relevant for policy-oriented studies, as it supports the reliability of country benchmarking even when different multi-criteria procedures are applied. Substantively, the results demonstrate that circular economy indicators serve as decisive differentiators in EU rankings. Countries that combine tourism development with higher levels of circularity achieve systematically better overall performance than those relying mainly on tourism flows. This finding is fully consistent with the CRITIC weighting results, which assigned higher informational importance to circular economy variables due to their greater dispersion and lower redundancy than traditional tourism indicators. In this sense, the ranking exercise provides empirical support for the argument that sustainable competitiveness in Europe increasingly depends on integrating tourism performance with circular-economy efficiency. The consistently high correlations confirm that the observed country hierarchy is not method-dependent, but rather reflects underlying multidimensional differences captured by the integrated indicator system. The stability of rankings across methods reinforces the robustness of the CRITIC-weighted decision matrix and supports the reliability of the

empirical findings. The limited magnitude and frequency of rank deviations, combined with the high Kendall's Tau coefficients, confirm that the ranking outcomes are highly stable and not sensitive to the choice of MCDM method. Kendall's Tau coefficients confirm strong, statistically significant agreement across all ranking methods (Table 6). All correlations are significant at the 1% level, indicating that the observed concordance is not due to random variation. The highest agreement is observed between ARAS and CoCoSo, while MOORA shows slightly lower, but still very strong consistency due to its different aggregation logic. Overall, the results confirm that the ranking structure is robust and method-independent.

Table 6: Pairwise comparison of the applied methods

Method Pair	**Kendall's τ**	**Sig. (p-value)**	**Decision**
MOORA – ARAS	0.887	0.003	Significant
MOORA – CoCoSo	0.872	0.000	Significant
ARAS – CoCoSo	0.912	0.017	Significant

Source: Authors' research

The rank difference analysis indicates that only a limited number of countries (10 out of 27) exhibit positional changes across the three methods, and these changes are strictly confined to ±1 rank. This indicates an exceptionally high degree of ranking stability (Table 7). The observed shifts occur primarily among mid-performing countries, where performance scores are relatively close, making minor methodological differences more influential. Importantly, no changes are observed among the top three or bottom three countries, confirming that the identification of leading and lagging economies is highly robust. The symmetry of changes in Sweden and Denmark, and in Greece and Ireland, further suggests that these differences are driven by variations in marginal scores rather than by structural inconsistencies.

Table 7: Ranking difference analysis for the most significant changes Δ

Country	**MOORA Rank**	**ARAS Rank**	**CoCoSo Rank**	**Δ(MOORA–ARAS)**	**Δ(MOORA–CoCoSo)**	**Δ(ARAS–CoCoSo)**
Netherlands	2	1	1	1	1	0
Germany	1	2	2	1	1	0
Spain	4	5	4	1	0	1
Italy	5	4	5	1	0	1
Sweden	8	9	8	1	0	1
Denmark	9	8	9	1	0	1
Greece	13	12	12	1	1	0
Ireland	12	13	13	1	1	0
Latvia	22	21	21	1	1	0
Estonia	21	22	22	1	1	0

Source: Authors' research

The ranking results reveal a clear stratification of EU-27 countries into leading, intermediate, and lagging groups, as well as the evolving structure of sustainable competitiveness in Europe. The top-performing countries, particularly the Netherlands, Germany, and France, demonstrate a balanced integration of tourism performance and circular economy efficiency, confirming that multidimensional sustainability criteria increasingly shape competitiveness in the contemporary EU context. These findings are consistent with recent EU policy directions, which explicitly emphasize the transition toward a circular tourism economy as a driver of sustainable growth and resilience. A comparison with recent European trends further reinforces this interpretation. EU tourism policy frameworks, particularly the European Green Deal, the EU's Circular Economy Action Plan and Transition Pathway for Tourism and the Circular Economy Action Plan, highlight the need to decouple economic

growth from resource use while maintaining tourism competitiveness. In this context, the leading countries in the ranking closely correspond to those that have already advanced in implementing circular economy practices, such as resource efficiency, recycling systems, and sustainable production models. This alignment suggests that the empirical ranking results are not only methodologically robust but also policy-consistent, reflecting real structural transformations occurring across EU economies. At the same time, the results highlight an important distinction between tourism-intensive economies (followers) and circular-economy leaders (frontrunners). Countries such as Spain, Italy, and Greece maintain strong positions due to their high tourism intensity. However, their relative ranking is moderated when circular economy indicators are incorporated. This indicates that traditional tourism competitiveness, based on volume, arrivals, and receipts, is increasingly insufficient on its own. Instead, competitiveness is being reshaped by the ability to integrate sustainability into tourism systems. Recent EU reports confirm that the tourism sector is undergoing a green and digital transition, in which sustainability performance is becoming a key determinant of long-term viability. The lower-ranking countries, including Romania and Bulgaria, face structural challenges in both tourism competitiveness and circular economy development. Their position reflects limited progress in resource efficiency, waste management, and circular material use, which constrains their overall performance. This finding is particularly relevant in light of EU policy objectives, which emphasize territorial cohesion and the need for all regions to participate in the circular transition. Reports on circular economy implementation across EU regions highlight persistent disparities and the importance of place-based policies to accelerate convergence. Tourism is both a driver of economic growth and a source of environmental pressure, particularly in terms of resource consumption and waste generation. The circular economy provides a framework for mitigating these pressures by promoting resource efficiency, waste reduction, and sustainable consumption patterns. At the same time, the adoption of circular practices enhances the resilience and attractiveness of tourism destinations, creating a positive feedback loop between sustainability and competitiveness. EU initiatives increasingly promote this integration, encouraging the development of circular business models, sustainable infrastructure, and eco-innovations within the tourism sector.

5. Conclusion

Increasing awareness of resource limitations and the need to maximize their value underscores the urgent need for substantial transformation within the tourism sector. This transformation entails replacing the traditional linear tourism model with a CE model. The major challenge in adopting CE in tourism lies in reducing waste and resource consumption, while increasing recycling rates, as well as resource productivity that would ensure sustainable growth. Accordingly, the study indicates that circular economy performance has become a critical determinant of national competitiveness in tourism. The leading positions of the Netherlands, Germany, and France underscore the significance of integrating tourism development with advanced resource efficiency, recycling systems, and circular material use. These countries represent a development model in which economic dynamism is closely aligned with sustainability principles, demonstrating that long-term competitiveness increasingly relies on such integration. In contrast, the relative repositioning of traditionally strong tourism economies such as Spain and Italy demonstrates the limitations of relying primarily on tourism intensity. Although these countries continue to achieve high rankings, the inclusion of circular economy indicators moderates their performance, suggesting that scale alone is insufficient within a multidimensional assessment framework. This result highlights the growing need to integrate sustainability into tourism strategies to sustain competitive advantage. Analysis of intermediate- and lower-ranking countries reveals that

comparable overall performance levels can result from structurally distinct combinations of strengths and weaknesses. Specifically, the contrast between circular economy leaders with moderate tourism intensity and tourism-specialized economies with weaker sustainability performance illustrates the diversity of development trajectories within the EU. At the lower end of the ranking, structural deficiencies in both tourism and circular economy dimensions limit overall competitiveness, underscoring the necessity for comprehensive and balanced policy interventions.

In summary, the study demonstrates that sustainable competitiveness in the EU tourism sector is increasingly influenced by the integration of circular economy principles. The findings are consistent with current EU policy frameworks and indicate that future progress will depend on member states' capacity to enhance tourism performance while advancing the transition toward resource-efficient and circular systems. However, several limitations should be acknowledged. The analysis is based on a calibrated dataset derived from harmonized World Bank and Eurostat indicators averaged over the 2021-2025 period, which may not fully capture short-term dynamics or country-specific fluctuations. In addition, the selected indicators, although widely recognized, do not encompass qualitative dimensions such as governance quality or institutional capacity. The CRITIC weighting method, while objective, relies on the data's statistical properties and may favor highly variable indicators; the applied ranking methods remain deterministic and do not explicitly account for uncertainty. Despite these limitations, the study offers important methodological and empirical contributions. It proposes an integrated framework that jointly evaluates tourism performance and circular economy efficiency, advancing beyond traditional single-domain analyses. The combined use of CRITIC weighting with the MOORA, ARAS, and CoCoSo methods ensures a data-driven, multi-perspective assessment, enhancing the robustness and consistency of country rankings. Moreover, the findings highlight the growing role of circular economy indicators as key determinants of sustainable competitiveness in the EU. Future research could extend this framework by incorporating fully empirical, higher-frequency data and a broader set of indicators that capture environmental, institutional, and innovation-related dimensions. Methodological advancements may include the application of fuzzy or stochastic MCDM approaches to address uncertainty, as well as dynamic analyses to capture temporal evolution in performance. Additionally, the framework could be applied to other regions or adapted to regional and sectoral levels, improving its generalizability and policy relevance. Furthermore, future studies could broaden the analytical scope by integrating hybrid methodological approaches that combine multi-criteria decision-making techniques with econometric or machine-learning models, enabling both ranking and causal inference. Sensitivity and robustness analyses could be expanded to systematically examine the impact of alternative normalization procedures, weighting schemes, and indicator selections on the stability of results. Another promising direction is to link the constructed performance indices with policy outcomes, such as economic growth, environmental sustainability, or social welfare indicators, to assess the real-world implications of tourism–circular economy interactions. Finally, incorporating spatial analysis and regional interdependencies would provide additional insights into spillover effects and convergence patterns within the EU, thereby enhancing the explanatory power and policy relevance of the proposed framework.

CRediT author statement

Žarko Rađenović: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Jelena Dimovski:** Writing – review & editing, Writing – original draft, Validation, Conceptualization, Supervision. **Valdas Dambrava:** Writing – review & editing, Writing – original draft, Validation, Conceptualization, Supervision, Project administration.

Declaration of generative AI in the writing process

During the preparation of this work, the authors used R and Tableau programs for the purpose of data visualization.

Conflict of interest

The authors declare no conflict of interest.

References

1. Arruda, E. H., Melatto, R. A. P. B., Levy, W., & Conti, D. d. M. (2012). Circular economy: A brief literature review (2015–2020). *Sustainable Operations and Computers*, *2*, 79–86. https://doi.org/10.1016/j.susoc.2021.05.001
2. Caponi, V. (2022). The economic and environmental effects of seasonality of tourism: A look at solid waste. *Ecological Economics*, *192*. https://doi.org/10.1016/j.ecolecon.2021.107262
3. Do, D. T. (2024). Assessing the impact of criterion weights on the ranking of the top ten universities in Vietnam. *Engineering, Technology & Applied Science Research*, *14*(4), 14899–14903. https://doi.org/10.48084/etasr.7607
4. Ekins, P., Domenech, T., Drummond, P., Bleischwitz, R., Hughes, N., & Lotti, L. (2019). *The circular economy: What, why, how and where*, OECD/EC. Retrieved February 2, 2026 from https://discovery.ucl.ac.uk/id/eprint/10093965/1/Ekins-2019-Circular-Economy-What-Why-How-Where.pdf
5. Ellen MacArthur Foundation (2013). *Towards the circular economy: Opportunities for the consumer goods sector*. Retrieved February 2, 2026 from https://www.ellenmacarthurfoundation.org/
6. *Eurostat* (n. d.). Retrieved January 20, 2026 from https://ec.europa.eu/eurostat
7. Florido, C., Jacob, M., & Payeras, M. (2019). How to carry out the transition towards a more circular tourist activity in the hotel sector. The role of innovation. *Administrative Sciencies*, *9*(2), 47. https://doi.org/10.3390/admsci9020047
8. Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy – A new sustainability paradigm? *Journal of Cleaner Production*, *143*, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048
9. Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, *114*, 11–32, https://doi.org/10.1016/j.jclepro.2015.09.007
10. Isik, C., Dogru, T., & Turk, E. S. (2018). A nexus of linear and non-linear relationships between tourism demand, renewable energy consumption, and economic growth: Theory and evidence. *International Journal of Tourism Research*, *20*(1), 38–49. https://doi.org/10.1002/jtr.2151
11. Kaszás, N., Keller, K., & Birkner, Z. (2022). Understanding circularity in tourism. *Society and Economy*, *44*(1), 65–82. https://doi.org/10.1556/204.2021.00025
12. Khan, O., Marrucci, L., Tiberio, D. & Bellini, N. (2021). Adoption of circular economy and environmental certifications: Perceptions of tourism SMEs. *Journal of Management and Sustainability*, *11*(1), 218–231. https://doi.org/10.5539/jms.v11n1p218
13. Khizar, H. M. U., Younas, A., Kumar, S., Akbar, A., & Poulova, P. (2023). The progression of sustainable development goals in tourism: A systematic literature review of past achievements and future promises. *Journal of Innovation & Knowledge*, *8*(4), https://doi.org/10.1016/j.jik.2023.100442

14. Kiaušienė, I., Valeriia, H., & Makūnaitė, G. (2024). Application of circular economy principles in the tourism sector. *Management Theory and Studies for Rural Business and Infrastructure Development*, *46*(1), 31–44. https://doi.org/10.15544/mts.2024.04
15. Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005
16. Li, K., Cipolletta, G., Andreola, C., Eusebi, A. L., Kulaga, B., Cardinali, S., & Fatone, F. (2024). Circular economy and sustainability in the tourism industry: Critical analysis of integrated solutions and good practices in European and Chinese case studies. *Environment, Development and Sustainability: A Multidisciplinary Approach to the Theory and Practice of Sustainable Development*, *26*, 16461–16482. https://doi.org/10.1007/s10668-023-03395-7
17. Manniche, J., Larsen, K.T., Broegaard, R. B. & Holland, E. (2017). *Destination: A circular tourism economy – A handbook for transitioning toward a circular economy within the tourism and hospitality sectors in the South Baltic Region*. Centre for Regional & Tourism Research (CRT): Bornholm, Denmark.
18. Mansi, E., Feruni, N., Ren, Y., Hysa, E., & Ndou, V. (2025). Sustainable journeys: Navigating the circular economy wave in EU tourism for a greener future. *Sustainability*, *17*, 8197. https://doi.org/10.3390/su17188197
19. Morseletto, P. (2020). Targets for a circular economy. *Resources, conservation and recycling*, *153*, 1–12. https://doi.org/10.1016/j.resconrec.2019.104553
20. Özdemir, D., & Tosun, B. (2023). Determinants of tourism demand in context of environmental quality. *Advances in Hospitality and Tourism Research* (AHTR), *11*(2), 294–316. https://doi.org/10.30519/ahtr.1096210
21. Peeters, P., & Landré, M. (2012). The emerging global tourism geography – An environmental sustainability perspective. *Sustainability*, *4*(1), 42–71. https://doi.org/10.3390/su4010042
22. Peeters, P., Çakmak, E., & Guiver, J. (2024). Current issues in tourism: Mitigating climate change in sustainable tourism research. *Tourism Management*, *100*, https://doi.org/10.1016/j.tourman.2023.104820
23. Rađenović, Ž., & Boshkov, T. (2023). Smart cities sustainability achievements ranking: PCA weighting. *SCIENCE International Journal*, *2*(4), 141–146. https://doi.org/10.35120/sciencej0204141r
24. Rađenović, Ž., & Marjanović, I. (2020). European travel and tourism ICT readiness: PCA/SWARA approach. In V. Bevanda., & S. Štetić (Eds.), *5th International Thematic Monograph*: *MODERN Management Tools and Economy of Tourism Sector in the Present Era* (pp. 131–145). Belgrade: Association of Economists and Managers of the Balkans; Ohrid: Faculty of Tourism and Hospitality. https://doi.org/10.31410/tmt.2020.131
25. Rađenović, Ž. J., & Rajić, M. N. (2024). Assessing circular economy performance of selected countries using MCDM methods: PROMETHEE vs. CoCoSo. In U. Tanveer, S. Ishaq, T. Huy, & T. Hoang (Eds.), *Navigating the Circular Age of a Sustainable Digital Revolution* (pp. 59–90). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-2827-9.ch003
26. Radivojević, V., Dimovski, J., & Mitić, G. (2023). Quantifying the financial impact of COVID-19 on the largest global companies in the hotel industry. *Hotel and Tourism Management*, *11*(1), 165–176. https://doi.org/10.5937/menhottur2301165R
27. Rasoolimanesh, S. M., Ramakrishna, S., Hall, C. M., Esfandiar, K., & Seyfi, S. (2023). A systematic scoping review of sustainable tourism indicators in relation to the sustainable development goals. *Journal of Sustainable Tourism*, *31*(7), 1497–1517. https://doi.org/10.1080/09669582.2020.1775621

28. Rodríguez, C., Florido, C., & Jacob, M. (2020). Circular economy contributions to the tourism sector: A critical literature review. *Sustainability*, *12*(11), 4338. https://doi.org/10.3390/su12114338
29. Rodríguez-Antón, J. M., & Alonso-Almeida, M. d. M. (2019). The circular economy strategy in hospitality: A multicase approach. *Sustainability*, *11*(20), 5665. https://doi.org/10.3390/su11205665
30. Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. *Environmental Development*, *17*, 48–56. https://doi.org/10.1016/j.envdev.2015.09.002
31. Sharma, V., Bumra, C., & Vats, V. (2025). *Circular economy in tourism industry: A sustainable approach, advancing sustainable development goals with educational technology*. IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-8242-4.ch005
32. Sorin, F., & Einarsson, S. (2020). *Circular economy in travel and tourism: A conceptual framework for a sustainable, resilient and future proof industry transition*. CE360 Alliance. Retrieved February 2, 2026 from https://circulareconomy.europa.eu/platform/sites/default/files/circular-economy-in-travel-and-tourism.pdf
33. Stanišić, T., Radivojević, V., & Dimovski, J. (2022). Interdependence of tourism competitiveness and development of Southern European countries. *Economics*, *61*(3), 1–11. https://doi.org/10.5937/ekonomika2203001S
34. Strippoli, R., Gallucci, T., & Ingrao, C. (2024). Circular economy and sustainable development in the tourism sector – An overview of the truly-effective strategies and related benefits. *Heliyon*, *10*(17). https://doi.org/10.1016/j.heliyon.2024.e36801
35. Suarez-Eiroa, B., Fernandez, E., Mendez-Martinez, G., & Soto-Onate, D. (2019). Operational principles of circular economy for sustainable development: Linking theory and practice. *Journal of Cleaner Production*, *214*, 952–961. https://doi.org/10.1016/j.jclepro.2018.12.271
36. *UN Tourism* (2026). Retrieved March 13, 2026 from www.unwto.org
37. *United Nations (UN)* (2026). Department of Economic and Social Affairs. Retrieved February 10, 2026 from www.un.org
38. UNWTO (2021). *Recommendations for the Transition to a Green Travel and Tourism Economy*. Madrid. https://doi.org/10.18111/9789284422814
39. Vatansever, K., Akarsu, H., & Kazançoğlu, Y. (2021). Evaluation of transition barriers to circular economy: A case from the tourism industry. *International Journal of Mathematical, Engineering and Management Sciences*, *6*(3), 824–846. https://doi.org/10.33889/IJMEMS.2021.6.3.049
40. Vávrová, J., Červová, L., & Brandová, B. (2025). The impact of sustainable practices on competitiveness in the hospitality industry. *Hotel and Tourism Management*, 13(2), 27–45. https://doi.org/10.5937/menhottur2500016V
41. Vranjanac, Ž., & Rađenović, Ž. (2022). EU countries hierarchical clustering towards circular economy performance indicators. *Facta Universitatis, Series: Working and Living Environmental Protection*, 149–155. https://doi.org/10.22190/FUWLEP2203149V
42. *World Bank* (n.d.). Retrieved January 20, 2026 from https://data.worldbank.org/indicator
43. *World Travel & Tourism Council (WTTC)* (2026). Retrieved February 2, 2026 from www.wttc.org
44. Yazdani, M., Gonzalez, E. D., & Chatterjee, P. (2021). A multi-criteria decision-making framework for agriculture supply chain risk management under a circular economy context. *Management Decision*, *59*(8), 1801–1826. https://doi.org/10.1108/MD-10-2018-1088

45. Zorpas, A. A., Navarro-Pedreño, J., Panagiotakis, I., & Dermatas, D. (2021). Steps forward to adopt a circular economy strategy by the tourism industry. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, *39*(7), 889–891. https://doi.org/10.1177/0734242X211029087