

Tourism, Waste Management, and Environmental Sustainability: A Bibliometric Review

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Abstract

The rapid global expansion of tourism has intensified environmental pressures, necessitating an urgent transition toward circular and sustainable waste management. This study presents a rigorous and comprehensive bibliometric synthesis of 703 Scopus-indexed publications (2004–2025), utilizing Bibliometrix (R) and VOSviewer to map the field's intellectual architecture. Findings reveal an exponential surge in research output after 2015, with the landscape organized into four primary clusters: sustainable tourism governance, waste management systems, circular economy, and marine pollution. The analysis uncovers a definitive paradigm shift from linear models toward regenerative frameworks, increasingly supported by smart technologies like IoT and machine learning. However, a persistent disciplinary divide between policy-oriented scholarship and technical research remains, hindering the development of truly holistic sustainability solutions. This work systematically identifies critical research gaps and proposes a socio-ecological roadmap for integrated governance. Policy recommendations underscore the need for cross-sectoral collaboration, circular strategies, and digital monitoring systems to enhance destination resilience. By effectively bridging the divide between technological innovation and policy formulation, this research provides a strategic foundation for the transition toward more sustainable and resilient global tourism systems.

Keywords: Tourism, Waste Management, Environmental Sustainability, Circular Economy, Bibliometric Analysis

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1. Introduction

Tourism has transformed into a significant global economic driver, substantially contributing to income generation, job creation, and regional development across many geographical contexts. In recent decades, the growth of international tourism has intensified due to globalization, enhanced connectivity, and increased disposable incomes, leading to an unprecedented rise in tourist mobility and consumption (Cruz-Sintes et al., 2020). While tourism is acknowledged for its developmental potential, its rapid and frequently unregulated expansion has generated intricate environmental issues, especially concerning resource utilization, waste generation, and ecosystem deterioration. The dual nature of tourism, functioning as both a catalyst for economic expansion and a source of environmental strain, has placed sustainability at the forefront of discussions on modern tourism (Krabokoukis, 2023; Sk & Sethy, 2025).

From a theoretical perspective, the environmental implications of tourism can be understood through the political ecology of tourism and the framework of metabolic rift, which highlight the disconnect between economic activity and ecological constraints (Shin et al., 2025). Tourism systems function through substantial material and energy flows, generating considerable waste as a by-product of consumption-driven activities. Tourists, frequently disengaged from local environmental responsibility, typically demonstrate elevated resource consumption relative to native populations, thus exacerbating waste production in destination locales (Bilynets & Cvelbar, 2020). This phenomenon is especially apparent in mass tourism, when transient populations impose excessive demands on local infrastructure and environmental systems. In this context, the notion of metabolic rift is significant for tourism systems, wherein the spatial disconnect between consumption (tourist practice) and waste assimilation leads to an ecological imbalance. Consumption associated with tourism is typically excluded in environmental costs pertaining to tourist destinations, leading to increased waste generation and environmental pressure in these regions. This behavioral disconnect highlights a critical limitation of purely technological or infrastructure-based solutions. While smart waste management systems and digital monitoring tools can enhance efficiency, their effectiveness is contingent upon the active participation of tourists and stakeholders. Therefore, addressing tourism-induced waste challenges requires an integrated approach that combines technological innovation with behavioral interventions, including awareness programs, nudging strategies, and participatory governance mechanisms.

Solid waste management has become a significant concern in vacation destinations, particularly in ecologically sensitive and resource-limited

areas. Tourism operations generate waste streams comprising plastics, food waste, packaging materials, and hazardous trash, many of which are non-biodegradable and environmentally persistent (Nayanarangani et al., 2022; Sk, 2024). Insufficient waste management practices such as open dumping, ineffective collection methods, and absence of segregation exacerbate land degradation, marine pollution, and greenhouse gas emissions (Manomaivibool, 2018; Sk, 2025). Coastal tourism locations are particularly susceptible, as plastic trash and marine debris pose direct threats to biodiversity and ecosystem services. These environmental externalities underscore the inherent limits of current tourism development approaches, which frequently prioritize economic benefits over ecological sustainability (Abdulkadir et al., 2025).

The concept of sustainable tourism has emerged as a significant regulatory and operational framework designed to harmonize economic development with environmental conservation. In this framework, waste management is progressively understood via the tenets of circular economy, which promote the reduction of resource inputs, the prolongation of product lifespans, and the minimization of waste outputs by reuse, recycle, and recovery methods (Sánchez et al., 2023). The change from linear to circular systems signifies a critical transformation in the management of tourism-related waste, transitioning from disposal-focused methods to resource-efficient and regenerative practices. Furthermore, the incorporation of technological advancements such as smart waste monitoring systems, Internet of Things-enabled infrastructure, and data-informed decision-making, has created new opportunities for improving the efficiency and sustainability of waste management within tourism settings (Dada et al., 2024; Sk, 2026). This technological innovation is optimal for tourism destinations with seasonal variations in visitors. The amount of waste produced peaks in the months with the highest number of tourists. Hence, tourist destinations and landmarks can be inundated with waste. Smart waste management facilitates monitoring and adaptive management of flows in real time, thereby allowing authorities to efficiently address sudden increases in waste. It also helps deploy resources during daytime. Therefore, this technology tackles the challenges posed by temporality and intensity of tourist waste generation. However, any technological interventions will be ineffective without changing behaviors. Waste management in tourism can be efficacious with the implementation of sustainable policy or efficient operation, coupled with behavioral change among tourists and stakeholders through awareness raising, incentives, and participatory governance mechanism.

Notwithstanding these conceptual and practical achievements, the current literature and theoretical frameworks on tourism, waste

management, and environmental sustainability remain fragmented. Research in this field is dispersed among various disciplines, such as environmental science, geography, urban studies, and hotel management, resulting in isolated and context-specific assessments (Meneses et al., 2024). Although prior research has addressed particular topics like plastic pollution, marine debris, and sustainable practices, there is a significant absence of a thorough, systematic synthesis that delineates the intellectual framework and research pathways within the discipline. This fragmentation constrains the advancement of integrated theoretical frameworks and evidence-based policy solutions (Loureiro et al., 2024).

Bibliometric analysis provides a rigorous methodological framework to overcome these limitations by methodically delineating the knowledge structure, research trends, and collaborative networks within a certain domain. Bibliometric techniques, through the analysis of extensive bibliographic data, facilitate the discovery of significant works, thematic clusters, and nascent research frontiers, thereby offering a meta-level comprehension of scholarly advancement (Cruz-Sintes et al., 2020). This method is especially pertinent for interdisciplinary fields such as tourism sustainability, where knowledge generation is dynamic and operates on several scales.

The novelty of this study resides in its comprehensive and theoretically grounded bibliometric assessment of the convergence of tourism, waste management, and environmental sustainability. This research, in contrast to previous studies that focus on specific subject areas, employs a comprehensive approach to elucidate the conceptual framework of the field, discerns prevailing and promising research issues, and critically analyzes the progression of sustainability discourse in tourism. The study enhances theoretical comprehension and practical significance of policies by integrating disparate literary elements with modern concepts like circular economy and technological innovation. It establishes a basis for formulating more cohesive and transdisciplinary strategies for sustainable tourism management amid increasing environmental difficulties. This study aims to provide a thorough bibliometric analysis of global research on tourism, waste management, and environmental sustainability, in order to map its evolution, identify significant research clusters, and delineate prospective research trajectories.

To systematically investigate the current knowledge structure and address the identified gaps within the existing literature, this study addresses the following research questions:

- What are the key bibliometric characteristics and growth trends of research in this field?

- Who are the most influential contributors?
- What are the patterns of collaboration and co-authorship in this domain?
- Which are the major research themes and how have they evolved over time?

2. Review of Literature

The scholarly discussion on tourism, waste management, and environmental sustainability has evolved significantly over time. Previous descriptive analyses of environmental consequences have progressively transformed into a more intricate and multidimensional inquiry into systemic transitions and sustainable paths. This transition signifies a growing recognition of the conflict between a rapid rise of the tourism sector and the ecological constraints of global ecosystems.

The interplay between tourism and environmental sustainability is frequently characterized as a "dual-role" dilemma, in which tourism acts both as a catalyst for economic advancement and as a factor in environmental deterioration (Cruz-Sintes et al., 2020). Although tourism creates employment, income, and regional growth, it simultaneously exacerbates demands on natural resources, ecosystems, and local surroundings. Recent study indicates that while scientific improvements have enabled the creation of sustainability-oriented practices, current literature focuses on economic benefits. The environmental and socio-cultural aspects of sustainability are underemphasized (Krabokoukis, 2023; Meneses et al., 2024). This disparity is especially pronounced in post-pandemic studies, where deliberations on "green recovery" and "smart tourism" have proliferated. Nevertheless, they frequently persist inside growth-oriented frameworks and warrant thorough investigation. (Krabokoukis, 2023; Shin et al., 2025).

Contemporary research increasingly embraces ecocentric and systems-based perspectives, perceiving Environmental, Social, and Governance (ESG) issues as dynamic and interrelated processes rather than as compliance obligations (Shin et al., 2025). Nonetheless, a persistent disagreement exists concerning the efficacy of these frameworks in mitigating the environmental impacts of incessant tourism growth. Critics contend that existing sustainability frameworks frequently overlook the fundamental structural disparities, often referred to as a "metabolic rift" between economic expansion and ecological constraints (Bilynets & Cvelbar, 2020). While literature highlights the need for fostering pro-environmental behavior among visitors, these individual-level initiatives are often hindered by overarching systemic shortcomings in governance,

infrastructure, and policy execution (Bilynets & Cvelbar, 2020). This necessitates a more cohesive and systematic approach to sustainability in tourism.

Waste generation constitutes an urgent environmental externality to tourism (Xu et al., 2021). Notwithstanding its importance, efficient waste management continues to pose a formidable problem in numerous tourist sites. Recent studies have increasingly focused on circular economy as a feasible alternative to conventional linear models of "take-make-dispose" (Sánchez et al., 2023). Methods like Life Cycle Assessment and Zero-waste frameworks have been utilized to assess waste reduction methods in many tourism contexts, including protected areas and the hotel industry (Abdulkadir et al., 2025; Miecoanski et al., 2025). Despite its theoretical allure, the implementation of a circular economy in tourism is still inadequately developed. Current research frequently prioritizes efficiency enhancements and resource optimization, while neglecting systemic resilience and long-term sustainability (Jones & Wynn, 2019).

This constraint is further emphasized by significant geographical differences. In developed locations, research mostly concentrates on sophisticated technology solutions, including smart waste monitoring and resource recovery systems. Conversely, research in developing nations specifically, the Maldives, Sri Lanka, and Thailand, underscores critical issues such as insufficient infrastructure and substantial waste production, with resort-centric tourism generating as much as 2.9 kg of food waste per capita daily (Manomaivibool, 2018; Nayanarangani et al., 2022). The seasonal characteristics of tourism impose significant pressure on municipal waste management systems, especially in emerging economies with constrained financial and institutional capacities. Empirical research from Indian hill regions and coastal areas indicates that even pioneering waste management initiatives frequently struggle to scale effectively without robust governance frameworks and stakeholder involvement (Abdulkadir et al., 2025; Dada et al., 2024; Gurung et al., 2025).

Bibliometric analysis is a crucial methodological tool for comprehending the emergent knowledge framework of tourism sustainability research (Bilynets & Cvelbar, 2020; Cruz-Sintes et al., 2020). Utilizing technologies like VOSviewer and Bibliometrix, recent research has identified significant topic clusters, including sustainable destination management and tourist behavior (Castillo-Quñones et al., 2023; Cruz-Sintes et al., 2020). The research output trajectory exhibits significant peaks, especially in 2017 and during the COVID-19 era (2020–2021), when researchers concentrated on the environmental consequences of tourism interruptions (Cruz-Sintes et al., 2020; Loureiro et al., 2024).

Notwithstanding these developments, current bibliometric investigations unveil a distinct "disciplinary silo" for sustainability. Research outputs are frequently restricted to tourism or environmental science journals, exhibiting minimal multidisciplinary integration (Sánchez et al., 2023). Although bibliometric methodologies have been utilized for specialized topics like pro-environmental behavior and economic sustainability, there is a dearth of thorough analyses that regard waste management as a pivotal element of the tourism-sustainability nexus (Bilynets & Cvelbar, 2020; Meneses et al., 2024; Trstenjak et al., 2023). Another lacuna is the emphasis of current studies on analytical approaches, which frequently favor descriptive metrics such as publication counts and citation rankings over more profound insights into the development of theoretical frameworks and knowledge systems (Loureiro et al., 2024; Trstenjak et al., 2023).

2.1. Research Gaps

Notwithstanding the rapid proliferation of research on sustainability, the current literature exposes some significant deficiencies. Firstly, there exists a continual fragmentation of disciplines, with tourism and waste management sometimes regarded as distinct areas. The absence of integration limits a comprehensive understanding of the interplay between waste systems, tourism dynamics, and governance frameworks (Bilynets & Cvelbar, 2020; Sánchez et al., 2023). Secondly, despite the increasing importance of concepts like circular economy and smart waste technologies, their implementation in research on tourism is still limited and theorized inadequately. Current research tends to be descriptive and context-dependent, lacking frameworks that are scalable and transferable (Sánchez et al., 2023; Shin et al., 2025).

Thirdly, contemporary bibliometric studies are restricted to geographical and methodological concerns, often concentrating on individual regions or databases. This limits the capacity to cultivate a thorough global comprehension of research trends and the evolution of knowledge (Cruz-Sintes et al., 2020; Trstenjak et al., 2023). There is a significant lack of longitudinal assessments that document the evolving nature of themes and philosophical frameworks. In the absence of such analyses, systematically identifying new patterns and potential research areas remains challenging (Loureiro et al., 2024; Trstenjak et al., 2023). Therefore, this study employs a comprehensive bibliometric method to offer an integrated and global perspective on tourism, waste management, and environmental sustainability in response to existing gaps.

3. Materials and Methods

This study used a bibliometric research design to review systematically the scientific literature on tourism, waste management, and environmental sustainability. Bibliometric analysis enables the quantitative assessment of academic publications and aids in the identification of research trends, significant contributions, and the intellectual framework of a domain (Cruz-Sintes et al., 2020; Krabokoukis, 2023). The methodological framework follows established protocols for data collection, screening, and analysis employing advanced software tools to ensure high-quality, consistent outcomes (Bilynets & Cvelbar, 2020; Bruyn et al., 2023). Primary data were obtained from the Scopus database, acknowledged as a credible source of peer-reviewed literature with extensive multi-disciplinary coverage (Castillo-Quñones et al., 2023; Cruz-Sintes et al., 2020). The search approach encompassed the years 2000 to 2025 to document the longitudinal development of the topic. A specific search string was used: (TITLE-ABS-KEY ("tourism" OR "tourist destinations") AND TITLE-ABS-KEY ("waste management" OR "solid waste" OR "plastic waste") AND TITLE-ABS-KEY ("environmental sustainability" OR "sustainable tourism")). This search focused on titles, abstracts, and keywords to ensure systematic retrieval of relevant works.

To ensure the quality of dataset used, the inclusion criteria limited the sample to English-language, peer-reviewed scientific publications that examine the intersection of tourism, waste, and sustainability (Bilynets & Cvelbar, 2020; Trstenjak et al., 2023). The exclusion criteria eliminated conference articles, book chapters, and editorials to maintain a uniform unit of analysis (Cruz-Sintes et al., 2020). The research employed a systematic screening procedure grounded in the PRISMA framework, as illustrated in the selection flowchart in Figure 1. After the preliminary identification of records, duplicates and irrelevant studies were eliminated using title and abstract review, succeeded by full-text screening to prepare the corpus for analysis (Trstenjak et al., 2023). A bibliometric study was performed leveraging the Bibliometrix R package and its Biblioshiny interface for descriptive mapping and performance assessment (Loureiro et al., 2024; Sánchez et al., 2023; Aria & Cuccurullo, 2017). Furthermore, VOSviewer was employed for network visualization, concentrating on co-authorship, co-citation, and keyword co-occurrence clusters (Cruz-Sintes et al., 2020; Ndou & Rampedi, 2022). These tools offer comprehensive analytical skills to identify significant contributions and thematic connections.

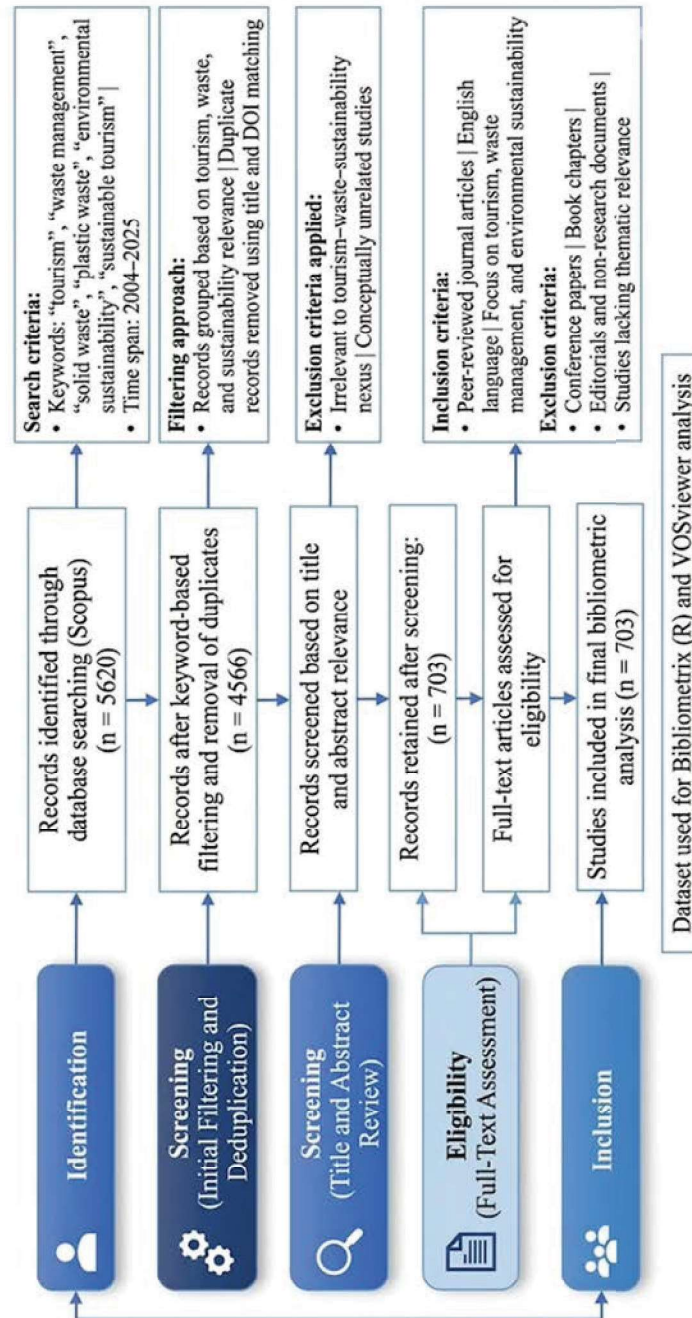


Figure 1: PRISMA flow diagram of the systematic literature selection process

The analytical techniques comprised two primary methodologies: performance analysis and science mapping. The performance study assessed the productivity of authors, journals, and institutions through indicators such as citation counts and h-index (Geng et al., 2025; Meneses et al., 2024). Science mapping analyzed collaboration patterns by co-authorship analysis and discerned intellectual underpinnings via co-citation analysis (Cruz-Sintes et al., 2020; Loureiro et al., 2024). Finally, keyword co-occurrence and topic evolution analysis were employed to identify principal research themes and new frontiers, offering a comprehensive perspective on the domain's trajectory (Florek-Paszkowska & Hoyos-Vallejo, 2023; Sánchez et al., 2023).

4. Results

The following sections provide a multidimensional bibliometric synthesis of 703 Scopus-indexed publications (2004–2025) concerning the intersection of tourism, waste management, and environmental sustainability.

4.1. General Bibliometric Profile of the Dataset

The dataset reveals a dynamic and rapidly maturing interdisciplinary domain, characterized by an annual growth rate of 25.38% and an average document age of 3.43 years. As summarized in Table 1, research is distributed across 358 distinct sources, reflecting a high degree of disciplinary cross-pollination between environmental sciences and tourism management. Collaborative density is significant, featuring 3,083 authors with an average of 4.71 co-authors per document and a 33.71% international collaboration rate. The conceptual richness of the field is further evidenced by 2,448 author keywords and 4,693 Keywords Plus, establishing a robust empirical foundation for structural exploration.

Table 1: Main Bibliometric Characteristics of the Dataset (2004–2025)

Indicator	Value
Timespan	2004–2025
Documents	703
Sources (Journals, Books, etc.)	358
Authors	3083
Annual Growth Rate (%)	25.38
Average Document Age (years)	3.43
Average Citations per Document	22.63
Keywords Plus (ID)	4693
Author's Keywords (DE)	2448

Indicator	Value
Co-authors per Document	4.71
International Co-authorship (%)	33.71

4.2. Annual Scientific Production and Citation Trends

Building upon this structural overview, the temporal trajectory of the field reveals a distinct shift in research intensity. Analysis indicates a transition from an exploratory phase (2004–2014), characterized by annual outputs of fewer than 10 articles, to an intermediate growth period (2015–2019) catalyzed by the adoption of the 2015 Sustainable Development Goals. Subsequently, production accelerated exponentially, rising from 42 articles in 2020 to 231 in 2025, as illustrated in Figure 2. Citation influence reached a conceptual peak between 2018 and 2020, with 2020 documents achieving a mean citation rate of 89.40, signifying high thematic relevance during the onset of the global pandemic (Table 2).

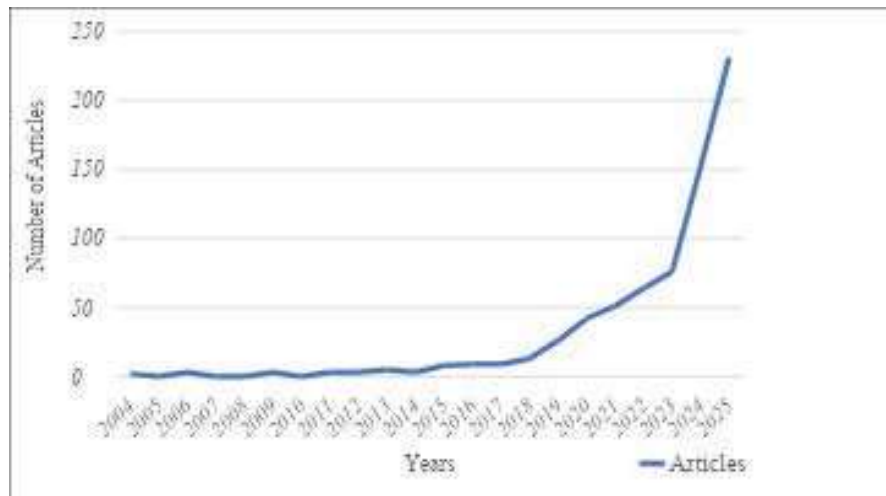


Figure 2: Annual scientific production and mean citation trends

Table 2: Annual Citation Characteristics of the Dataset

Year	Mean Citations per Article	Number of Articles	Mean Citations per Year	Citable Years
2004	8.00	2	0.35	23
2006	77.67	3	3.70	21
2009	82.33	3	4.57	18
2011	59.33	3	3.71	16

Year	Mean Citations per Article	Number of Articles	Mean Citations per Year	Citable Years
2015	41.88	8	3.49	12
2018	85.54	13	9.50	9
2020	89.40	42	12.77	7
2022	23.91	64	4.78	5
2024	9.16	152	3.05	3
2025	2.23	231	1.11	2

4.3. Source Analysis: Most Productive Journals

The expansion of research output is closely tied to the specific academic venues that have prioritized these thematic intersections. Research is heavily concentrated within high-impact environmental and sustainability-focused journals. Table 3 highlights that *Sustainability* leads with 60 publications, followed by *Waste Management* and *Science of the Total Environment*. Other significant venues include *Resources*, *Conservation and Recycling* and *Scientific Reports*. Furthermore, Bradford's Law identifies a core-periphery structure characteristic of emerging fields (Figure 3). This distribution confirms that knowledge production has shifted from purely tourism-centric perspectives to integrated sustainability frameworks addressing circular transitions and waste valorization.

Table 3: Top 10 most relevant sources by publication volume

Rank	Journal Name	Number of Articles
1	Sustainability (Switzerland)	60
2	Waste Management	38
3	Science of the Total Environment	27
4	Resources, Conservation and Recycling	16
5	Scientific Reports	15
6	Journal of Environmental Management	14
7	International Journal of Environmental Research and Public Health	12
8	Cleaner Waste Systems	9
9	Materials	8
10	Resources	8

Source: Compiled using Bibliometrix (R) based on Scopus dataset

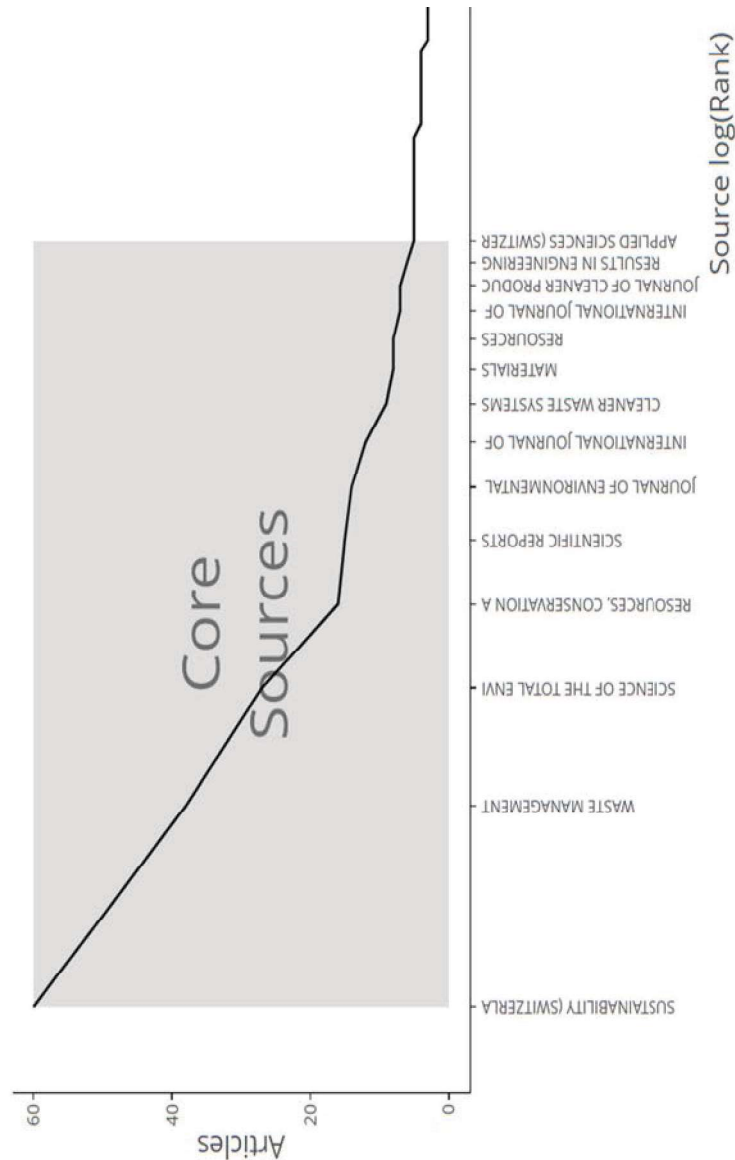


Figure 3: Core sources distribution based on Bradford's Law

4.4. Author and Institutional Productivity

Beyond the fields of publication, the intellectual landscape is shaped by a core group of influential researchers and institutional hubs. Analysis reveals a moderately focused authorship pattern within a globally distributed landscape. Adisa Azapagic is identified as the most productive and influential author (10 documents; 848 citations), followed by Elena Cristina Rada (Figure 4). Institutional leadership is centered in

Europe and Asia; notably, the University of Aveiro and IDAEA-CSIC achieve the highest citation impact (591 citations each), while Zhejiang University also demonstrates significant research output, as detailed in Table 4.

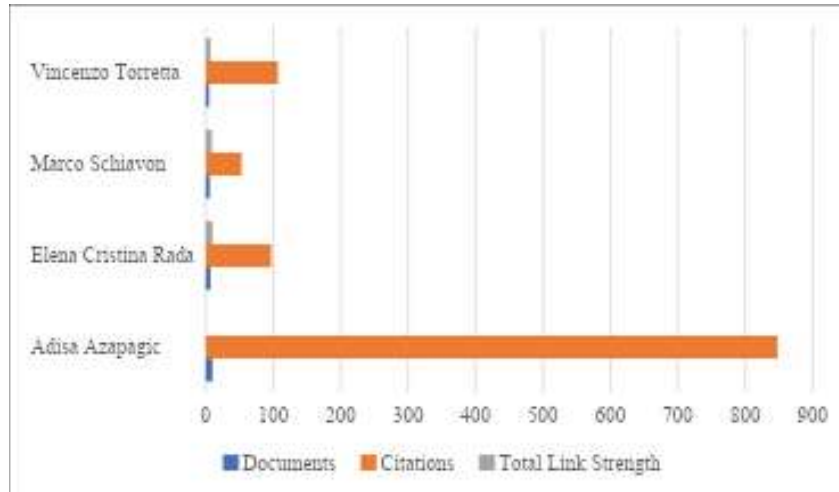


Figure 4: Most Productive Authors and Their Bibliometric Indicators

Table 4: Selected Leading Institutions and Their Bibliometric Indicators

Institution	Documents	Citations	Total Link Strength
University of Aveiro (Portugal)	2	591	4
IDAEA-CSIC (Spain)	2	591	4
Zhejiang University (China)	2	438	2
CSIR-IITR, Lucknow (India)	2	191	0
University of Warwick (UK)	2	91	0
ETH Zurich (Switzerland)	2	104	0

4.5. Country-wise Scientific Production and Impact

These institutional contributions are situated within a broader geographical framework of scientific production. Geographical analysis, visualized in Figure 5, highlights the dual dominance of Italy (150 publications), China, and India, reflecting established European policy

frameworks alongside intensifying waste management pressures in rapidly urbanizing Asian economies. While the United Kingdom leads in aggregate citation impact, specialized contributors like France (105.50) and Portugal (96.09) achieve superior average citation rates (Table 5), suggesting high thematic relevance despite lower absolute volumes.

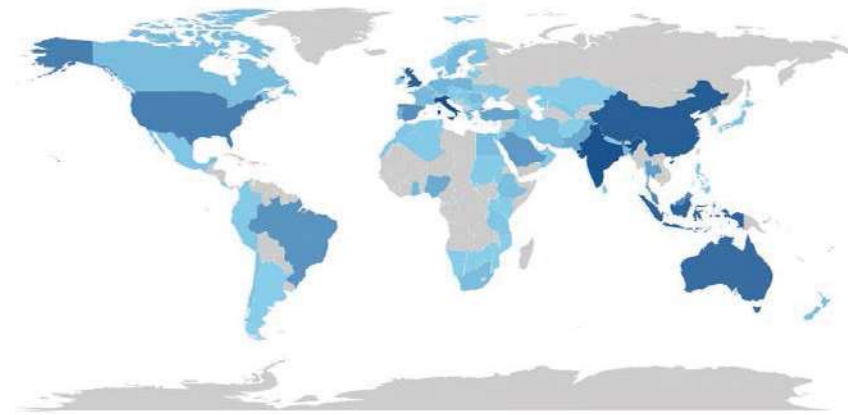


Figure 5: Global Distribution of Scientific Production by Country

Table 5: Total Citations and Average Citation Impact by Country

Rank	Country	Total Citations	Average Citations per Article
1	United Kingdom	1670	35.53
2	Italy	1534	32.64
3	China	1482	42.34
4	Portugal	1057	96.09
5	Australia	920	38.33
6	Spain	738	28.38
7	France	633	105.50
8	United States	609	29.00
9	South Korea	470	78.33
10	India	436	9.28

4.6. Collaboration and Co-authorship Networks

The global distribution of research naturally facilitates cross-border scholarly engagement. Co-authorship analysis reveals a robustly collaborative environment, characterized by a 33.71% international

collaboration rate. Network mapping identifies distinct regional hubs, specifically a dense European cluster and a significant Asia-Pacific nexus (Figure 6). While the UK and USA serve as central nodes with high total link strength, author-level networks exhibit localized fragmentation; influential figures like Rada and Torretta show high engagement, whereas others operate with lower link strength, as shown in Figure 7.

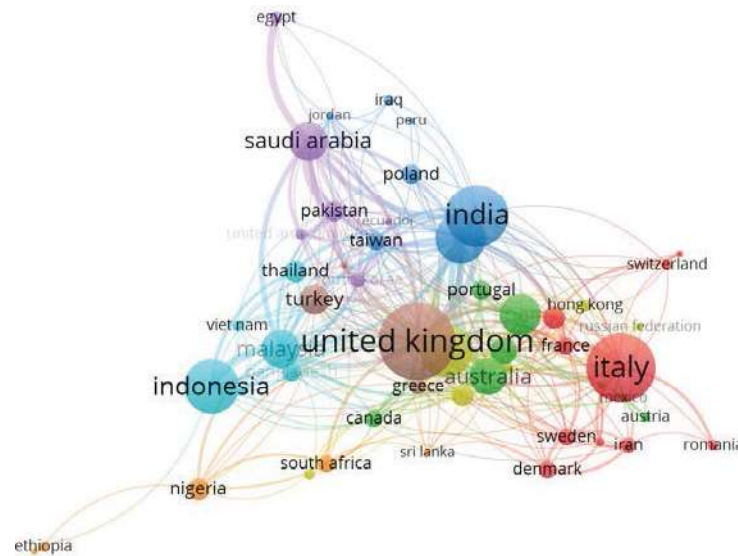


Figure 6: Co-authorship Network among Countries

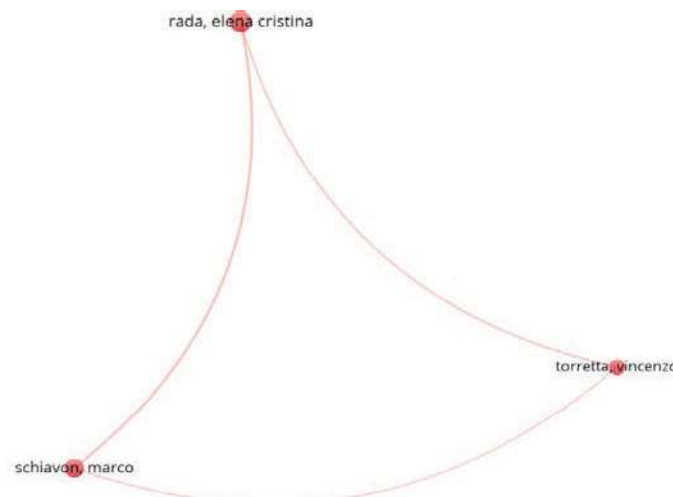


Figure 7: Author-level Co-authorship Network

4.8. Thematic Evolution of Research

The assessment of thematic evolution (2004–2025) reflects a longitudinal transition from foundational problem identification to advanced, technology-driven solutions. The findings indicate that the early phase (2004–2010) was primarily exploratory, focusing on visible externalities like solid waste and landfills. This transitioned during the intermediate phase (2011–2015) toward sustainability principles and policy-oriented approaches, significantly influenced by the Sustainable Development Goals. The analysis shows that the recent expansion phase (2016–2025) signifies a paradigm shift toward circular and regenerative systems, prioritizing resource recovery and waste-to-energy. This period is marked by the integration of digital innovations specifically IoT and machine learning alongside heightened responsiveness to global crises like COVID-19 and climate change. Ultimately, the longitudinal data confirms a progression from reactive, problem-oriented inquiry to holistic, systems-oriented research, underscoring the field's maturation and its alignment with global environmental agendas.

4.9. Co-citation Analysis and Knowledge Structure

Co-citation analysis (Small, 1973; Cobo et al., 2011) delineates a multidimensional intellectual landscape characterized by four distinct thematic clusters. The first cluster focuses on sustainable tourism governance, emphasizing the integration of global policy frameworks, such as the Sustainable Development Goals, and stakeholder-led institutional mechanisms. The second cluster addresses the technical-operational dimensions of waste management, prioritizing environmental assessments and the mitigation of ecological externalities within tourism systems. The third cluster reflects a paradigm shift from linear models toward the circular economy and resource efficiency, utilizing life cycle assessments and waste valorization to optimize production-consumption systems. A fourth specialized stream examines the impacts of marine plastic pollution on coastal tourism biodiversity. Collectively, the network reveals a core-periphery structure where foundational studies underpin emerging research. While convergence is evident between circularity and waste management, the weak linkage between policy-oriented discourse and technical research indicates persistent structural fragmentation. This necessitates deeper interdisciplinary integration to harmonize governance with technological sustainability solutions.

5. Discussion

The exponential surge in research output since 2020 representing a significant departure from the exploratory phase of 2004–2014 – indicates a

profound "transformative turn" in the field's conceptual maturity. This trajectory suggests that waste management is no longer a peripheral operational concern but a central pillar of tourism resilience. As Gössling et al. argued, the COVID-19 pandemic acted as a critical disruptor, exposing the inherent fragilities of linear consumption models and compelling a radical reassessment of tourism's environmental footprint in a post-crisis era (Carpendale et al., 2023). However, this shift cannot be merely blamed on the pandemic. Transformative changes were already in motion prior to 2020, being propelled by global policy frameworks like the UN Sustainable Development Goals (2015) and the European Union Circular Economy Action Plan, which shaped sustainability discourse and research agendas. Consequently, the pandemic acted as an accelerator of transitions that were already underway rather than a unique inflection point. Theoretically, this shift reflects a transition from "reactive" waste mitigation to "proactive" sustainability governance, aligning with broader global agendas.

A central theme emerging from the keyword analysis is the consolidation of the Circular Economy as the dominant paradigm for resource optimization. The transition to keywords such as "resource recovery" and "waste-to-energy" signifies an attempt to reconfigure tourism as a closed-loop socio-ecological system (Sánchez et al., 2023). However, a critical analysis of this transition reveals a conceptual tension. While the bibliometric data shows high thematic interconnectedness between "circular economy" and "waste management," there remains a risk of "circularity-lite" applications. As Kirchherr et al. observed, CE is frequently reduced to basic recycling (3R) rather than the radical systemic redesign required for true sustainability (Kirchherr et al., 2017). The results support this critique, showing that while technical recovery methods are well-documented, the higher-level R-strategies (e.g., refuse, rethink) remain underrepresented in tourism-specific discourse.

Furthermore, the disciplinary distribution reveals a persistent imbalance, with environmental and engineering journals dominating the production landscape over traditional tourism outlets. This "silo effect" suggests that while the technical dimensions of waste management are advancing rapidly, they remain partially decoupled from the socio-behavioral and management-oriented frameworks of hospitality studies. This fragmentation is further evidenced by the co-citation analysis, which identifies a "core-periphery" structure where foundational environmental theories provide the intellectual bedrock, yet tourism-specific policy integration remains at the periphery (Cobo et al., 2011).

The emergence of "smart" technologies, including IoT and machine learning, indicates a shift toward data-driven environmental governance. This digitalization trend suggests that the future of sustainable tourism lies

in the integration of real-time monitoring and predictive analytics into destination management (Alonso-Muñoz et al., 2022; Madzík et al., 2023). For policymakers, the findings underscore that infrastructure alone is insufficient; effective waste management requires integrated digital governance that bridges the gap between technical engineering and tourism planning. Ultimately, achieving a holistic sustainability transition requires moving beyond fragmented collaborations toward a truly interdisciplinary synthesis that harmonizes global environmental standards with local tourism dynamics (Geissdoerfer et al., 2016).

6. Limitations and Future Research

This study presents an unabridged, bibliometric analysis of literature on touristic waste management and environmental sustainability. However, it is not without its limitations. Firstly, the analysis is only based on the Scopus database. Though Scopus covers a broad range of relevant literature published within peer-reviewed journals, it excludes studies indexed in other databases (Web of Science, Google Scholar or regional research repositories). These articles are not included in this study. Secondly, the identification of research needs only covers published studies (in English), which may overlook some best practices from non-English-speaking regions which report some of the highest number of nature reserves and tourism-related environmental tipping points. Thirdly, bibliometric analysis is mainly based on quantitative indicators including the publication count, citation counts and keyword frequency. These do not cover qualitative aspects that are included in a traditional literature review, as it includes contextual information or theoretical richness of studies. Thus, deciphering thematic architectures and investigation trends should be interpreted as indicative and not exhaustive. This is problematic because the choice of keywords used by authors is contingent on individualistic preferences on indexing.

Long term studies using multilingual datasets may help provide a more global view through longer-term multi-database nationwide cohorts. The combination of bibliometric methodologies with a systematic literature review or qualitative meta-synthesis would assist in providing richer theoretical insights and thereby contextualize similar research. More empirical research needs to be conducted to connect innovations on the technological and behavioral dimensions of aspects in the tourism waste management context- especially from a developing perspective. Finally, further research is to be done on context-specific frameworks including policy-oriented approaches for easily implementable sustainable and circular waste management strategies across various tourism contexts.

7. Conclusion and Policy Implications

This study provides a comprehensive bibliometric synthesis of research concerning tourism, waste management, and environmental sustainability, characterizing the domain as a rapidly expanding and increasingly interdisciplinary field. The findings confirm a decisive paradigm shift, particularly post-2015, moving from fragmented, problem-oriented studies toward integrated, systems-based analytical frameworks. The consolidation of dominant thematic clusters, namely sustainable tourism governance, waste management systems, circular economy, and marine pollution, demonstrate that sustainability has become the central paradigm in tourism scholarship. Furthermore, the rising prominence of circular economy principles and digital technologies signals a strategic transition toward resource-efficient and data-driven sustainability solutions. Despite these advancements, the study identifies persistent structural imbalances that hinder holistic progress. While the technical and environmental dimensions of waste management are theoretically and operationally well-developed, their integration with tourism policy and destination governance are limited and indicate a continued disciplinary fragmentation. This gap necessitates the establishment of stronger conceptual and operational linkages between environmental engineering, tourism planning, and broader sustainability governance frameworks to ensure that technical innovations are supported by robust institutional structures.

From a policy perspective, the findings advocate for the adoption of integrated and multi-level governance approaches. Policymakers should prioritize circular waste management strategies that move beyond linear consumption models, promote active cross-sectoral collaboration, and invest in smart technologies to enhance operational efficiency and accountability. Additionally, strengthening institutional frameworks and fostering meaningful behavioral change among tourists and stakeholders are essential prerequisites for achieving long-term ecological resilience. Most notably, this study will help to address the previously identified structural fragmentation in tourism by bringing together a broad evidence base for past research domains through a systematic bibliometric synthesis. The paper brings a unique conceptual and analytical perspective by systematically linking tourism studies with frameworks such as waste management, circular economy and sustainability. The thematic clusters, patterns of collaboration and knowledge structures allow researchers to understand strategically how policy-related and technical research streams can be aligned better. In this way, the study provides an important stepping stone to bridge disciplinary silos and enable a more integrated approach to sustainable tourism research.

References

- Abdulkadir, A., Ally, B., Remmen, A., Hirsbak, S., & Salukele, F. (2025). Circular Economy Framework for Plastic Waste Management: A Case Study from Coastal Hotels in Zanzibar. *Resources*, 14(11), 175. <https://doi.org/10.3390/resources14110175>
- Alonso-Muñoz, S., Torrejón-Ramos, M., Medina Salgado, S., & González-Sánchez, R. (2022). Sustainability as a building block for tourism – future research: Tourism Agenda 2030. *Tourism Review*, 78(2), 461-474. <https://doi.org/10.1108/TR-12-2021-0568>
- Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11, 959-975. <https://doi.org/10.1016/j.joi.2017.08.007>
- Bilynets, I., & Cvelbar, L. K. (2020). Past, Present and Future of the Research on the Pro-Environmental Behaviour in Tourism: A Bibliometric Analysis. *Economic and Business Review*, 22(2). <https://doi.org/10.15458/eb102>
- Bruyn, C. de, Said, F. B., Meyer, N., & Soliman, M. (2023). Research in tourism sustainability: A comprehensive bibliometric analysis from 1990 to 2022. *Heliyon*, 9(8). <https://doi.org/10.1016/j.heliyon.2023.e18874>
- Carpendale, G., Caton, K., Grimwood, B. S. R., Munar, A. M., & Stinson, M. J. (2023). With in Dangerous Times: Proceedings 2022. In *Research Portal Denmark* (p. 218). Technical University of Denmark. <https://local.skningsportal.dk/local/dki-cgi/ws/cris-link?src=cbs&id=cbs-8f5d27c0-3664-4815-8e35-c5aa16f0c3aa&ti=With%20in%20Dangerous%20Times%20%3A%20Proceedings%202022>
- Castillo-Quñones, C. S., Serrano-Leyva, B., & Díaz-Pompa, F. (2023). Bibliometric study about sustainable tourism product in Scopus database. *Revista Interamericana de Ambiente y Turismo*, 19(1), 90. <https://doi.org/10.4067/s0718-235x2023000100090>
- Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology*, 62(7), 1382. <https://doi.org/10.1002/asi.21525>
- Cruz-Sintes, A., Santos-Assán, A. H., Díaz-Pompa, F., Aguilera, N. C., & Balseira-Sanamé, Z. (2020). Estudio bibliométrico de los artículos originales encontrados en Sciencedirect sobre turismo y sostenibilidad

- ambiental. *RECUS Revista Electrónica Cooperación Universidad Sociedad* ISSN 2528-8075, 5(2), 31. <https://doi.org/10.33936/recus.v5i2.2693>
- Dada, M. A., Obaigbena, A., Majemite, M. T., Oliha, J. S., & Biu, P. W. (2024). Innovative Approaches to Waste Resource Management: Implications for Environmental Sustainability and Policy. *Engineering Science & Technology Journal*, 5(1), 115. <https://doi.org/10.51594/estj.v5i1.731>
- Florek-Paszkowska, A., & Hoyos-Vallejo, C. A. (2023). A comprehensive bibliometric analysis and future research directions in the nexus of sustainable business practices and turnover intention. *Cleaner and Responsible Consumption*, 11, 100146. <https://doi.org/10.1016/j.clrc.2023.100146>
- Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2016). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>
- Geng, Y., Zhao, S., Zhang, X., Li, J., Yan, Y., & Gao, J. (2025). Bibliometric analysis of sustainable rural tourism. *Humanities and Social Sciences Communications*, 12(1). <https://doi.org/10.1057/s41599-025-05213-z>
- Gössling, S., Scott, D., & Hall, C. M. (2020). Pandemics, tourism and global change: A rapid assessment of COVID-19. *Journal of Sustainable Tourism*, 29, 1–20. <https://doi.org/10.1080/09669582.2020.1758708>
- Gurung, P., Sharma, R., Sarkar, P. S., & Sarkar, S. (2025). Waste and tourism: Drivers of sustainable waste management practices in the tourism industry. *Social Sciences & Humanities Open*, 12, 102290. <https://doi.org/10.1016/j.ssaho.2025.102290>
- International Tourism Highlights, 2020 Edition. (2021). In *World Tourism Organization (UNWTO) eBooks*. <https://doi.org/10.18111/9789284422456>
- Jones, P., & Wynn, M. (2019). The circular economy, natural capital and resilience in tourism and hospitality. *International Journal of Contemporary Hospitality Management*, 31(6), 2544. <https://doi.org/10.1108/ijchm-05-2018-0370>
- 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>
- Krabokoukis, T. (2023). Exploring the State of Research on Tourism Sustainability: A Bibliometric Analysis in the Post-COVID

- Era. *Highlights of Sustainability*, 2(2), 50. <https://doi.org/10.54175/hsustain2020005>
- Loureiro, I., Costa, V., & Malheiro, A. (2024). Sustainable Tourism: A Systematic Literature Review and Bibliometric Analysis. *European Journal of Tourism, Hospitality and Recreation*, 14(1), 127. <https://doi.org/10.2478/ejthr-2024-0009>
- Madzík, P., Falát, L., Copuš, L., & Valeri, M. (2023). Digital transformation in tourism: Bibliometric literature review based on machine learning approach. *European Journal of Innovation Management*, 26(7), 177-205. <https://doi.org/10.1108/EJIM-09-2022-0531>
- Manomaivibool, P. (2018). Tourism and Municipal Solid Waste Management in Developing Economies: Challenges and Opportunities. *Open Access Journal of Waste Management & Xenobiotics*, 1(2). <https://doi.org/10.23880/oajwx-16000112>
- Meneses, D., Costa, C., Ferreira, F. A., & Eusébio, C. (2024). A bibliometric overview of economic sustainability in tourism. *European Journal of Tourism, Hospitality and Recreation*, 14(2), 245. <https://doi.org/10.2478/ejthr-2024-0018>
- Miecoanski, L. F., Oliveira, G., Carstens, D. D. dos S., Zilli, F. F., Azevedo, H. de, Silva, J., Florentino, L. C., & Detoni, T. A. (2025). Waste Management in Tourism: a Study in an Environmental Conservation Park in Light of the Circular Economy. *Revista de Gestão Social e Ambiental*, 19(3). <https://doi.org/10.24857/rgsa.v19n3-104>
- Nayanarangani, M. D. P., Dissanayaka, D. M. S. H., & Jayaneththi, J. P. H. U. (2022). Solid wastes generation and its management in tourist destinations of Sri Lanka. *Global Journal of Engineering and Technology Advances*, 12(2), 106. <https://doi.org/10.30574/gjeta.2022.12.2.0144>
- Ndou, V., & Rampedi, I. T. (2022). Bibliometric Analysis of Municipal Solid Waste Management Research: Global and South African Trends. *Sustainability*, 14(16), 10229. <https://doi.org/10.3390/su141610229>
- Sánchez, R. G., Alonso-Muñoz, S., Salgado, S. M., & Torrejón-Ramos, M. (2023). Driving circular tourism pathways in the post-pandemic period: a research roadmap. *Service Business*, 17(3), 633. <https://doi.org/10.1007/s11628-023-00537-9>
- Shin, H., Jo, Y., Lee, S., Park, J., Cho, J., & Kim, H. (2025). ESG for Sustainability in Hospitality and Tourism: A Theoretical and Practical Review with a Future Research Agenda. *Journal of Travel Research*, 65(1), 3. <https://doi.org/10.1177/00472875251363629>

- Sk, M. M. (2025). Trash to trouble: Revealing the environmental costs of poor waste management in Durgapur. *Journal of Geographical Studies*, 1(9), 69. <https://doi.org/10.21523/gcj5.25090105>
- Sk, M. M., & Sethy, T. (2025). Tourism, cultural heritage, and sustainability in Balangir, Odisha, India: An evaluation of identity conservation and economic growth. *South Asian Journal of Social Studies and Economics*, 22(4), 147–159. <https://doi.org/10.9734/sajsse/2025/v22i4991>
- Sk, M.M. (2024). Assessing vulnerability of a solid waste management system through GIS and the Rank Sum method: A case study of Durgapur city, India. *Advances in Environmental Technology*, 11(1), 36-62. <https://doi.org/10.22104/aet.2024.7053.1939>
- Sk, M.M. (2026). Estimation of greenhouse gas emissions from municipal solid waste landfill, Durgapur, India. *International Journal of Environment and Waste Management*, 31(5), 200-216. <https://doi.org/10.1504/IJEWM.2024.10067389>
- Small, H. (1973). Co-citation in the scientific literature: A new measure of the relationship between two documents. *Journal of the American Society for Information Science*, 24(4), 265. <https://doi.org/10.1002/asi.4630240406>
- Trstenjak, A., Žiković, I. T., & Žiković, S. (2023). How to Make EU Tourism Sector Greener, more Efficient and Sustainable: A Bibliometric Analysis. *International Journal of Energy Economics and Policy*, 13(2), 77. <https://doi.org/10.32479/ijeep.13926>
- Xu, X., Feng, C., Zhen, D., Tan, Y., & Lai, Q. (2021). Evaluation of the environmental costs of tourism based on an energy analysis of tourism waste disposal: A case study of Yarlung Zangbo Grand Canyon National Park in Motuo County, Tibet. *Environmental Science and Pollution Research*, 28(25), 32708-32720. <https://doi.org/10.1007/s11356-021-12829-6>