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Technological Innovation for Sustainable Tourism: A Bibliometric Study Through a Knowledge-Production Bias Lens

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Abstract

This study maps and diagnoses research on technological innovation for sustainable tourism through a knowledge production bias and governance lens. It analyses Scopus indexed journal articles published between 2010 and 2023 (N = 1,044), retrieved via seven TITLE-ABS-KEY queries, merged and deduplicated, and documented using an adapted PRISMA 2020 style flow. Retrieval validity was bounded through manual validation (precision = 74.0%) complemented by a two-coder check. VOSviewer science mapping used full counting and a minimum keyword occurrence threshold (min. occurrences = 5) to generate keyword co-occurrence, overlay visualisation (average publication year), and country and author co authorship networks supported by exported Items lists. The field shows strong growth and a conceptual structure centred on smart, digital, and AI related narratives embedded within broad sustainability framings. Collaboration networks indicate core and periphery visibility, and within the mapped country set the top five countries account for approximately 40% of both output and citations, indicating concentrated agenda visibility. Governance coded constructs appear less central in the high frequency conceptual core at the applied threshold, suggesting potential blind spots in linking innovation mechanisms to sustainability outcomes. Findings are bounded to publication metadata and mapped networks rather than destination performance or policy readiness, yet they provide actionable implications by highlighting the need to pair technology adoption with governance readiness, including measurement, transparency, and accountability, and to foreground fairness and responsibility considerations more explicitly in innovation agendas.

1. Introduction

Technological innovation is increasingly positioned as a key lever for advancing sustainable tourism, with smart destination infrastructures, platform intermediation, and data-driven applications (e.g., AI, IoT, analytics) reshaping how tourism services are designed, delivered, and coordinated (Gretzel et al., 2015; Sigala, 2020). Parallel to this digital intensification, sustainable tourism debates have expanded beyond environmental efficiency to include socio-cultural integrity, distributional equity, and long-term institutional capacity (Hall, 2019; Milano et al., 2019). Consequently, innovation discourse in tourism has become tightly interwoven with sustainability agendas. However, the relationship remains neither linear nor universally beneficial across contexts, particularly when governance capacity and accountability arrangements are uneven (Hall, 2019; Sigala, 2020; Xiang et al., 2021, Çakar, 2023).

A central theoretical tension underpins this intersection, where innovation is often framed as a solution to sustainability challenges, yet sustainability outcomes depend on governance arrangements, accountability mechanisms, and evaluation architecture rather than adoption alone

(Hall, 2019; Gelter et al., 2021). Tourism scholarship cautions that technology-enabled sustainability claims can be overstated when measurement systems are weak, stakeholder coordination is fragmented, or ethical and distributional concerns are treated as secondary (Gelter et al., 2021; Abdelmalak, 2025). Moreover, data-intensive innovation can introduce non-trivial environmental and

social trade-offs, reinforcing the need to evaluate not only “what technologies are used” but also “how they are governed” and “which outcomes are prioritised” (Sigala, 2020; Rahmadian et al., 2022; Yaseen et al., 2022).

Conceptual ambiguity further motivates closer scrutiny. Terms such as “technological innovation,” “digital transformation,” and “smart tourism” are frequently used interchangeably despite referring to different mechanisms, organisational logics, and policy implications (Gretzel et al., 2015; Sigala, 2020). Building on foundational definitions, smart tourism can be viewed as an ecosystem in which digital connectivity and data infrastructures enable new forms of value creation and destination operations (Gretzel et al., 2015), while “smart tourism destinations” are simultaneously shaped by how stakeholders interpret, translate, and govern smartness in practice (Gelter et al., 2021). In this study, technological innovation is treated as the application of digital and data-driven mechanisms (e.g., AI, IoT, platforms, analytics, blockchain, AR/VR) that alter tourism decision-making, service delivery, or destination management processes (Gretzel et al., 2015; Sigala, 2020; Yaseen et al., 2022). Sustainability outcomes refer to intended or measured improvements across environmental performance, socio-cultural resilience, and governance quality (Hall, 2019; Milano et al., 2019). This operational clarity responds directly to reviewer concerns that prior mapping efforts can assert novelty without specifying what remains conceptually underdefined.

Bibliometric methods are well suited for mapping rapidly expanding literatures, yet leading outlets increasingly expect bibliometric studies to provide an analytical intervention beyond descriptive mapping (Donthu et al., 2021; Köseoglu et al., 2016). Bibliometrics maps patterns in publication metadata (keywords, citations, and co-authorship links), and therefore cannot, by itself, validate destination performance or policy readiness; its contribution depends on careful interpretation of structures, boundaries, and blind spots (Donthu et al., 2021). This expectation is particularly salient because bibliometric and review work has already expanded across tourism sustainability, smart destinations, and data-driven innovation, raising the originality threshold for additional mapping unless a distinct interpretive lens is clearly articulated (Köseoglu et al., 2016; Rahmadian et al., 2022).

While existing mapping work has improved topical visibility, it remains less common for bibliometric studies in this domain to diagnose how knowledge production is structured through concentration of output and influence, core periphery collaboration visibility, and thematic dominance that may render governance and outcome evaluation constructs less central in the most visible streams

(Donthu et al., 2021; Köseoglu et al., 2016). This matters because policy relevance in innovation-for-sustainable-tourism debates depends on explicit mechanism-to-outcome reasoning and governance conditions, not on technology visibility alone (Hall, 2019; Gelter et al., 2021).

Responding to this threshold, this paper advances a knowledge production bias and governance oriented interpretation of bibliometric evidence. Knowledge production bias refers to structural patterns such as concentration of output and influence within a relatively narrow core, clustered collaboration networks, and thematic dominance that can shape agenda setting and the visibility of governance relevant

concerns (Donthu et al., 2021; Köseoglu et al., 2016). Empirically, the study draws on a Scopus retrieved dataset (2010–2023) constructed through multiple query retrieval, merging, and deduplication, documented via a PRISMA 2020 style flow diagram (adapted) and strengthened by a retrieval validation check to bound false positives (Donthu et al., 2021). Science mapping and network analysis are implemented using established bibliometric tooling to support transparent reporting of conceptual clusters, temporal overlay patterns, and collaboration visibility (Aria & Cuccurullo, 2017).

Accordingly, the study pursues three objectives. First, it maps publication growth, dominant contributors, and conceptual structure in innovation for sustainable tourism research (2010–2023) using bibliometric performance indicators and keyword co-occurrence mapping (Donthu et al., 2021; Aria & Cuccurullo, 2017). Second, it examines collaboration structures at country and author levels to diagnose visibility and connectivity patterns that may shape knowledge diffusion and agenda concentration (Köseoglu et al., 2016). Third, it interprets thematic dominance and potential blind spots through a governance lens, focusing on whether technology mechanisms are structurally prioritised over evaluation and accountability language (Hall, 2019; Gelter et al., 2021). To avoid over-claiming context specific insights from publication metadata, the analysis remains global in scope and is interpreted as evidence of knowledge structure rather than destination level performance or policy readiness.

In doing so, the study offers a distinctive diagnostic angle for bibliometric research in sustainable tourism by applying a knowledge-production bias lens to quantify concentration and network visibility and to translate these patterns into a focused research agenda around governance and measurement blind spots.

2. Literature Review

2.1 Sustainable tourism and governance

Sustainable tourism is frequently presented as a guiding paradigm for destination development, yet it remains conceptually demanding because it must reconcile environmental constraints, socio-cultural integrity, and long-term institutional capacity. Hall (2019) argues that sustainability discourse in tourism can become overly “managerial” if it is reduced to efficiency language while governance arrangements, trade-offs, accountability, and enforceable outcomes are treated as secondary. This governance sensitivity becomes highly visible in overtourism contexts, where resident backlash and carrying capacity pressures demonstrate that sustainability is not only a technical challenge but also a political and distributional one (Milano et al., 2019; Hall, 2019).

A recurring limitation, therefore, is the weak coupling between normative sustainability claims and evaluative architectures. Without clear institutional mechanisms and accountability, sustainability risks becoming an elastic label rather than an operational framework that supports consistent policy learning and measurable destination management (Hall, 2019). This is important for innovation studies because technologies are often introduced as “solutions” (monitoring, optimisation, nudging), yet the governance

criteria that define what counts as “success” (thresholds, equity, legitimacy, and responsibility) can remain under-specified (Hall, 2019). As a result, research that treats technological adoption as inherently sustainability enhancing risks overlooking the conditions under which innovation plausibly produces outcomes across the sustainability dimensions (Hall, 2019).

2.2 Smart tourism and innovation

Smart tourism scholarship established an influential foundation by conceptualising smartness as an ecosystem in which ICT and data infrastructures enable new forms of value creation and coordination across destinations, firms, and visitors (Gretzel et al., 2015). However, a persistent critique is that “smart tourism” can become a catch-all label if it is used as shorthand for any digitalisation process, thereby weakening theoretical precision and encouraging interchangeable use of adjacent terms such as technological innovation and digital transformation (Gretzel et al., 2015; Sigala, 2020). This conceptual drift matters because it blurs distinctions between technologies as mechanisms, organisational transformation as process, and governance as an enabling architecture.

A second critique concerns “tech-solutionism,” where technology adoption is implicitly treated as a sufficient condition for sustainability improvement. Sigala (2020) shows that the acceleration of digitalisation during COVID-19 strengthened technology-led transformation narratives, yet it also amplified governance dilemmas related to uneven capacity, legitimacy, and distribution of benefits. Meta-narrative synthesis further indicates that “smartness” is shaped by how stakeholders interpret and govern technological change, meaning that institutional framing and meaning-making influence what smart tourism becomes in practice (Gelter et al., 2021). Therefore, the relevant analytical problem is not only identifying dominant technologies, but interrogating how the field conceptualises the mechanism outcome link and whether governance logics are treated as central or peripheral (Hall, 2019; Gelter et al., 2021).

2.3 Measurement and outcomes

A governance aware approach to innovation for sustainable tourism requires explicit outcome measurement. Global tourism policy discussions increasingly emphasise measurement infrastructure particularly for climate action-because sustainability claims require baselines, indicators, and reporting systems to be credible and comparable (UN Tourism, 2023). Yet measurement is not a neutral technical step; it is a governance activity involving standard-setting, transparency, and accountability for how indicators are selected and how results are interpreted.

From a critical perspective, the sustainability promise of data-driven tools can be overstated when “data availability” is conflated with “improved outcomes.” A systematic review of big-data applications for sustainable tourism indicates uneven evidence and significant variation in how sustainability is operationalised, suggesting that governance and evaluation remain weak points even when advanced analytics are introduced (Rahmadian et al., 2022). This reinforces the need to diagnose whether measurement and accountability language is structurally embedded in the knowledge base or remains less visible relative to technology-centric narratives (Hall, 2019; Rahmadian et al., 2022).

2.4 Bibliometrics and contribution

Bibliometric approaches are increasingly used to map fast growing literatures, but methodological guidance stresses that bibliometrics primarily captures patterns in publication metadata (keywords, citations, and collaboration links) and must be interpreted cautiously to avoid purely descriptive contributions (Donthu et al., 2021). Tourism specific reflections similarly argue that bibliometric studies gain theoretical value when they do more than list prolific authors or frequent keywords-namely, when they clarify conceptual boundaries, reveal contradictions, and identify blind spots that matter for cumulative theory building (Köseoglu et al., 2016; Donthu et al., 2021).

This contribution threshold is particularly salient because tourism sustainability and innovation have already been subject to extensive synthesis. Consequently, additional bibliometric mapping is unlikely to be considered original unless it offers a distinctive analytical angle, such as interrogating concentration, core-periphery visibility, and thematic dominance as agenda-setting structures (Köseoglu et al., 2016; Donthu et al., 2021). In other words, bibliometrics becomes competitive in leading outlets when it provides diagnostic interpretation rather than descriptive confirmation.

2.5 Study positioning

Building on these critiques, the present study positions its contribution as a governance, oriented diagnosis of the knowledge structure in innovation for sustainable tourism. First, it adopts transparent dataset construction and reproducible mapping procedures aligned with bibliometric best-practice expectations (Donthu et al., 2021). Second, it moves beyond descriptive cluster labelling by interpreting collaboration and conceptual structures as evidence of knowledge-production patterns, concentration, clustered networks, and thematic dominance, that may influence agenda-setting (Köseoglu et al., 2016). Third, it explicitly links these diagnostics to governance concerns-measurement, accountability, and evaluation thereby reframing the debate away from technology inventories toward outcome-relevant blind spots and boundary ambiguities (Hall, 2019; Rahmadian et al., 2022).

2.6 Research gaps

Despite the rapid growth of research on innovation for sustainable tourism, three interrelated gaps remain evident. First, the literature often privileges technology visibility (AI/IoT/analytics and smart destination narratives) over outcome specification and governance evaluation. This produces a recurring means-ends ambiguity where innovation is implicitly treated as beneficial while the criteria for sustainability success-accountability, measurable indicators, ethical data practices, and institutional capacity-remain comparatively under theorised and unevenly operationalised (Hall, 2019; Sigala, 2020; Gelter et al., 2021). As a result, the field risks reinforcing tech-solutionist framings instead of clarifying the conditions under which innovation plausibly translates into sustainability outcomes (Hall, 2019; Rahmadian et al., 2022).

Second, conceptual boundaries remain blurred. “Smart tourism,” “digital transformation,” and “technological innovation” are frequently used interchangeably, which obscures distinctions between

technologies as mechanisms, organisational change as process, and governance as an enabling architecture (Gretzel et al., 2015; Sigala, 2020; Xiang et al., 2021). This conceptual drift weakens cumulative knowledge building because it becomes unclear whether studies analyse comparable mechanisms or simply adopt fashionable labels. Consequently, there is a need for synthesis work that clarifies conceptual boundaries and traces how dominant framings evolve over time, including which bridging concepts connect technology mechanisms to outcome-oriented sustainability debates (Gretzel et al., 2015; Gelter et al., 2021).

Third, while bibliometric studies are widely used in tourism research, methodological guidance stresses that science mapping must move beyond descriptive clustering to offer an interpretive contribution (Köseoglu et al., 2016; Donthu et al., 2021). Many bibliometric applications map frequent keywords or prolific contributors but do not systematically examine how the field's knowledge is structured, including the concentration of output and citations, the visibility of a central core in collaboration networks, and the dominance of particular thematic framings that can marginalise governance constructs (Donthu et al., 2021; Köseoglu et al., 2016). This is particularly important in innovation for sustainability debates because governance and measurement are precisely where policy relevance is determined, yet these constructs may not appear centrally in high frequency conceptual cores (Hall, 2019; Rahmadian et al., 2022).

Against this backdrop, the present study addresses these gaps by interpreting bibliometric evidence diagnostically through a knowledge-production bias and governance lens. By combining keyword structure, temporal overlay, and co-authorship networks, the study clarifies dominant conceptual boundaries, identifies agenda concentration patterns, and highlights potential governance blind spots that shape how innovation for sustainable tourism is conceptualized and operationalised.

3. Methodology

3.1 Design

This study adopts a bibliometric research design to map publication and collaboration patterns at the intersection of innovation and sustainable tourism and to interpret the field through a knowledge production bias and governance lens. Bibliometric methods are appropriate for systematically analysing publication metadata (e.g., keywords, citations, and co-authorship links) using transparent, replicable indicators.

3.2 Data source

Records were retrieved from Scopus and exported as CSV files on 25 February 2026. Scopus was used due to its broad interdisciplinary coverage across tourism, hospitality, sustainability, and technology-related journals. Scopus was used as a single source to ensure consistent metadata for science mapping; database coverage bias is addressed as a limitation.

3.3 Search strategy

To operationalise the innovation sustainable tourism intersection with clear construct coverage, a multiple query retrieval strategy was implemented. Each query was anchored in the phrase “sustainable tourism” and paired with a technology/innovation mechanism frequently examined in tourism and hospitality research. Seven searches were executed and exported separately:

1. “Sustainable tourism” AND “smart tourism”
2. “Sustainable tourism” AND “digital transformation”
3. “Sustainable tourism” AND “technological innovation”
4. “Sustainable tourism” AND “artificial intelligence”
5. “Sustainable tourism” AND “internet of things”
6. “Sustainable tourism” AND “blockchain”
7. “Sustainable tourism” AND “big data”

The exact Scopus syntax, field restrictions (TITLE-ABS-KEY), search date, and applied filters are reported in Appendix A to ensure full replicability.

3.4 Eligibility criteria

To avoid incomplete year bias in annual trend analysis, the analytical window was restricted to 2010–2023 (complete publication years). Records were limited to English language, peer-reviewed journal articles to improve comparability across publications and ensure consistency in bibliometric performance and science-mapping outputs.

3.5 Dataset construction, screening, and deduplication

All seven Scopus exports were merged into a single dataset. Overlaps across exports were expected; therefore, deduplication was treated as an explicit methodological step to prevent double counting. Duplicate records were removed using DOI matching where available, complemented by title-year matching where DOI was missing. The multiple query retrieval returned 1,412 records. Deduplication removed 368 duplicates, resulting in 1,044 unique records. The dataset was retained within the predefined eligibility criteria (2010–2023; journal articles; English), yielding a final analytical sample of N = 1,044.

To provide transparent reporting of record identification and dataset construction, a PRISMA 2020-style flow diagram adapted for bibliometric dataset construction is presented in Fig. 1 (record selection and dataset construction, Scopus 2010–2023). No additional records were excluded after duplication because eligibility was enforced at retrieval through the multi-query design and applied filters (Fig. 1).

3.6 Science mapping procedures (VOSviewer)

VOSviewer was used to generate: (i) country co-authorship networks to describe collaboration visibility (Fig. 3), (ii) keyword co-occurrence networks to map the conceptual structure of the field (Fig. 4), (iii) overlay visualisation to examine temporal shifts via average publication year (Fig. 5), and (iv) author co-

authorship networks to characterise collaboration clustering and bridging patterns (Fig. 6). Keyword co-occurrence mapping applied full counting with a minimum occurrence threshold (min. occurrences = 5), and total link strength (TLS) was reported to reflect co-occurrence connectivity. For each map, exported VOSviewer Items lists (occurrences, TLS, and cluster membership/overlay scores) were used to support quantitative reporting rather than relying on visual inspection alone.

3.7 Retrieval validation

A manual retrieval validation check was conducted to bound false positives and strengthen the replicability of scope decisions. Two coders independently screened a subset of 25 records (drawn from the validation sample) based on an operational inclusion rule requiring substantive presence of: (i) a tourism/hospitality context, (ii) sustainability outcomes, and (iii) a technology/innovation mechanism in the title/abstract/keywords. Inter-coder agreement was 76.0% (19/25) with Cohen's kappa = 0.35, indicating fair agreement for a three-criteria scope rule. Disagreements (6/25) largely reflected borderline cases where sustainability was explicit, but the technology mechanism was only implicitly stated or weakly signalled in the bibliographic metadata. All disagreements were resolved through adjudication to reach a consensus coding, which was used to finalize the validation procedure. These two coder checks complement the retrieval precision estimate (74.0%) by increasing confidence that inclusion/exclusion decisions are not driven by single-coder judgement.

3.8 Limitations

The study is limited to Scopus-indexed English-language journal articles and may underrepresent outputs in non-indexed outlets or other languages. Bibliometric evidence maps patterns in publication metadata (e.g., keywords, citations, and collaboration links) and does not, by itself, provide direct evidence on destination performance, policy readiness, or realised sustainability outcomes. Accordingly, governance implications are interpreted within the limits of bibliometric evidence.

4. Results

This section reports bibliometric performance and science-mapping outputs for the Scopus-retrieved dataset covering 2010–2023 (N = 1,044). Results are presented in six parts: publication trend, country profile, keyword structure, temporal overlay, co-authorship networks, and bias diagnostics.

4.1 Publication trend

The dataset shows a clear growth trajectory over time. As reported in Table 1 and visualised in Fig. 2, annual output remains modest in the early 2010s, followed by sustained expansion after 2017 and a marked acceleration during 2020–2023. This pattern indicates increasing scholarly attention to technology-enabled and data-driven sustainability themes in tourism research over the later period of the dataset.

Table 1
Annual publication output (2010–2023; N = 1,044)

Year	Publications	Year	Publications
2010	5	2017	58
2011	12	2018	61
2012	7	2019	83
2013	14	2020	126
2014	23	2021	163
2015	28	2022	190
2016	33	2023	285

4.2 Country profile

Documents and citations reflect the mapped country set in VOSviewer (full counting); TLS and Links indicate collaboration visibility in the co-authorship network. As summarised in Table 2 and visualised in Fig. 3, the highest contributing countries by document volume include China (Documents = 194; TLS = 70), Italy (111; TLS = 53), Spain (78; TLS = 38), India (58; TLS = 31), and Portugal (54; TLS = 30). These countries also display relatively higher connectivity (Links/TLS), indicating stronger collaboration visibility within the mapped country network.

Table 2
Top countries (from VOSviewer Country Items)

Rank	Country	Documents	Citations	Links	TLS	Avg. pub. year
1	China	194	3,953	27	70	2020.66
2	Italy	111	2,651	24	53	2019.65
3	Spain	78	2,590	16	38	2020.01
4	India	58	888	20	31	2021.76
5	Portugal	54	1,172	14	30	2020.37
6	Indonesia	47	592	18	30	2021.28
7	United Kingdom	46	3,388	29	52	2020.17
8	Greece	40	856	16	31	2020.98
9	Malaysia	39	1,150	18	37	2021.13
10	United States	39	2,209	24	49	2020.44

Interpretation note

The network reflects collaboration visibility in the mapped set and should not be interpreted as a direct measure of national innovation performance or policy readiness.

4.3 Keyword structure

As visualised in Fig. 4 and summarised in Table 3, the keyword network is organised around highly connected anchors that combine smart/digital tourism language with broad sustainability framings. The most frequent items serve as central connectors in the co-occurrence space, while governance-coded terms appear with lower occurrence relative to the dominant technology and sustainability anchors at the applied threshold, supporting a governance relevant interpretation of thematic dominance.

Table 3
Cluster summary (Keyword structure)

Cluster	Theme label	Terms (n)	Total occurrences	Top terms (occurrences)
1	Digital transformation & XR	16	130	Digital transformation (21); iot (16); ict (13)
2	Smart tourism & AI/IoT	14	317	Smart tourism (120); artificial intelligence (49); smart cities (47)
3	Sustainable tourism & smart destinations	14	204	Sustainable tourism (91); technology (20); smart destination (16)
4	Sustainability, climate & mobility	12	212	Sustainability (103); covid-19 (23); renewable energy (13)
5	Sustainable development & heritage/rural	10	146	Sustainable development (78); cultural heritage (17); rural tourism (8)
6	Smart city & blockchain	9	113	Smart city (56); blockchain (16); citizen science (7)
7	Innovation, industry & resilience	8	87	Innovation (27); tourism industry (18); smart specialization (10)
8	Tourism core & decision support / bibliometrics	7	126	Tourism (83); digitalization (11); bibliometric analysis (10)

Table 4
Condensed actionable implications framework (metadata-bounded)

Governance-ready action + suggested indicators (examples)	Key implication	Evidence pattern (Results)
Establish outcomes-first programmes with baselines/targets; **indicators**: baseline + targets documented; reporting cycle defined	Agenda visibility may be shaped by a narrow core	Output and citation concentration in mapped countries (Top 5 ≈ 40%; Table 2; Fig. 3)
Build cross-context partnerships and shared datasets; **indicators**: partnership MoU in place; shared dataset repository established; joint outputs planned	Knowledge diffusion may be uneven across contexts	Core collaboration visibility (higher TLS/links for central nodes; Fig. 3; Fig. 6)
Embed governance-by-design; **indicators**: accountability matrix (RACI) completed; evaluation plan approved pre-rollout; audit trail defined	Risk of adoption without accountability and evaluation	Technology-forward dominance and limited governance centrality (Fig. 4; Table 3; Result 4.6)
Standardise mechanism/outcome taxonomy for screening and policy use; **indicators**: taxonomy document approved; periodic reliability check scheduled	Conceptual ambiguity in "technology mechanism" signalling	Validation boundary condition (precision = 74%; Section 3.7)

4.4 Temporal overlay

As shown in Fig. 5, the overlay visualisation based on average publication year indicates a shift in emphasis over time. Earlier-period terms cluster around general sustainability and tourism development framings, whereas more recent terms are increasingly associated with data-driven innovation narratives (e.g., AI- and smart/digital-related labels), suggesting an intensification of technology- forward vocabulary in the later years of the dataset.

Figure 5. **Overlay visualization by average publication year (VOSviewer; 2010–2023).**

4.5 Co-authorship networks

As visualised in Fig. 6, the author co-authorship network exhibits clustered collaboration communities with limited bridging between groups, indicating that collaboration tends to occur within bounded teams rather than a fully integrated network. This structure is consistent with uneven connectivity patterns observed across the mapped collaboration space.

Figure 6. **Author co-authorship network (VOSviewer; 2010–2023).**

4.6 Bias diagnostics

To align with the study's focus on knowledge-production biases, performance and network structures are interpreted diagnostically rather than descriptively. Country level document counts are based on full counting of country affiliations in VOSviewer; therefore, totals can exceed the number of unique articles (N = 1,044) because multi-country co-authored papers contribute to more than one country.

Within the mapped country set (VOSviewer country items), output is noticeably concentrated. The top five countries by document volume account for 495 of 1,236 documents (40.0%), indicating that a relatively small core contributes a disproportionate share of research production. Citation influence shows a similar pattern: when ranked by citations, the top five cited countries (China, the United Kingdom, Italy, Spain, and the United States) account for 14,791 of 36,311 citations (40.7%), suggesting that impact is likewise captured by a narrow core rather than being widely distributed across the network.

Collaboration structures reinforce this concentration. Countries with higher total link strength (TLS) and more collaboration links occupy more central positions in the co-authorship network (e.g., China TLS = 70; United Kingdom TLS = 52; Italy TLS = 53; United States TLS = 49), reflecting stronger visibility through international collaboration connectivity and, by implication, greater agenda-setting capacity within the mapped knowledge space. In contrast, many other countries appear with fewer links and lower TLS values, indicating more peripheral visibility and weaker integration into the dominant collaboration structure.

Conceptual mapping further suggests thematic dominance patterns that are relevant for governance oriented interpretation. Smart/digital/AI-related terms are strongly embedded alongside broad sustainability anchors, indicating that technology-forward framing occupies a central position in the high frequency conceptual space. Explicit governance terms are present but comparatively less central at the applied threshold (e.g., “governance” and “smart governance” appear with lower occurrences than the dominant technology anchors). Notably, equity/justice/accountability terms do not emerge among the high-frequency items at the chosen threshold, signalling a potential blind spot: governance and outcome-evaluation constructs may be less visible in the most connected thematic streams where innovation-for-sustainable-tourism debates are being consolidated.

5. Discussion

This study sets out to move beyond descriptive bibliometric mapping by interpreting the innovation-sustainable tourism knowledge base through a knowledge-production bias and governance lens. The results indicate that the domain expanded substantially during 2010–2023 (N = 1,044), with growth patterns reported in Table 1 and conceptual structures organised around a technology-forward core embedded within broad sustainability framings. The overlay visualisation (Fig. 5) further suggests that technology-centred labels become more visible in later years, consistent with the increasing prominence of data-driven narratives in tourism innovation discourse. Importantly, these patterns are derived from publication metadata and should be read as indicators of knowledge structure rather than direct evidence of destination performance or policy readiness.

A first interpretive takeaway concerns agenda concentration. The bias diagnostics show that research production and citation influence are disproportionately concentrated within a relatively small set of countries in the mapped collaboration space (Top 5 shares ≈ 40% for output and ≈ 41% for citations

within the mapped country set; see Table 2 and Fig. 3). Because country-level counts in VOSviewer are based on full counting of affiliations, these concentration indicators reflect collaboration visibility in the mapped network rather than national performance. Nonetheless, such concentration signals a “core” that holds greater visibility and influence in shaping dominant framings, reinforced by country network centrality (higher TLS and links for a narrow group).

A second takeaway concerns core-periphery visibility in collaboration. The country co-authorship network (Fig. 3) shows that highly connected nodes (higher TLS/links) occupy more central positions, while many others are less connected and therefore less visible in the mapped collaboration structure. Author-level patterns (Fig. 6) similarly exhibit clustered collaboration communities, suggesting bounded research communities rather than a fully integrated global network. While bibliometrics cannot establish causal explanations, these structures are consistent with a knowledge system in which collaboration visibility can shape the diffusion of concepts, methods, and preferred problem framings.

A third takeaway concerns thematic dominance and governance blind spots. The keyword co-occurrence structure (Fig. 4, summarised in Table 3) indicates that innovation mechanisms (smart/digital/AI-related concepts) are structurally embedded alongside general sustainability anchors. However, governance coded language is less prominent in the high-frequency conceptual core at the selected threshold, and equity/justice/accountability terms do not appear among the dominant items. This does not imply absence in the wider literature, but it does suggest that governance concerns may be less structurally central in the most visible conceptual space compared with technology mechanisms. From a governance lens, this imbalance matters because sustainability outcomes are ultimately mediated through institutions, standards, measurement, and accountability architectures.

Adopting a knowledge production bias lens shifts bibliometric evidence from descriptive mapping to diagnostic interpretation by foregrounding concentration and core periphery visibility. In this dataset, Top-5 shares are ≈ 40% for both output and citations within the mapped country set, and a narrow collaboration core (higher TLS/links) holds greater visibility, patterns that are consistent with the central embedding of smart/digital/AI narratives in the high-frequency conceptual core while governance-coded constructs are less central at the applied threshold (Fig. 4; Table 3). Importantly, retrieval validation (precision estimate = 74.0%) provides a boundary condition for interpretation: the multi-query strategy captures predominantly in-scope literature, yet a non-trivial share of records references sustainability without an explicit technology mechanism in the title/abstract/keywords. Together, these findings support cautious reading and motivate a focused agenda: strengthening mechanism to outcome theorisation by embedding governance and measurement constructs more explicitly in innovation for sustainable tourism research.

6. Implications

6.1 Theoretical implications

The findings support a governance, oriented conceptualisation of innovation for sustainable tourism. Rather than treating innovation as a generic driver, the mapped knowledge structure indicates that the field is increasingly organised around mechanism visibility (smart/digital/AI narratives) while governance-coded constructs are comparatively less central in the dominant conceptual core. This implies that future theorisation should model innovation outcome pathways more explicitly as mediated by institutional capacity, accountability, and measurement systems, rather than assuming that technology adoption is inherently outcome producing.

The diagnostic reading also highlights persistent boundary ambiguity. The clustering of smart tourism, digital transformation, and technology related terms within central thematic streams suggests that scholars frequently mobilise overlapping labels. A clearer distinction between mechanisms (specific technologies), processes (transformation pathways), and governance architecture (rules, standards, coordination) would strengthen cumulative theory building and reduce conceptual drift.

6.2 Methodological implications

This study illustrates how bibliometric work can be strengthened through (i) transparent dataset construction (PRISMA-style reporting), (ii) retrieval validation to bound false positives, and (iii) reporting not only cluster labels but also cluster composition and network visibility indicators. For future bibliometric studies in tourism, contribution is likely to be enhanced when science mapping outputs are interpreted diagnostically, focusing on concentration, collaboration visibility, and the identification of potential blind spots, rather than being used only to confirm broad, expected thematic categories.

6.3 Managerial and policy implications

Although bibliometric evidence cannot measure destination performance, the mapped knowledge structure indicates which framings dominate innovation-for-sustainability discourse. The prominence of smart/digital/AI-related themes suggests that decision-makers may increasingly encounter technology centred narratives as a default solution set. This heightens the importance of governance readiness: clear evaluation indicators, transparency in data practices, and accountability mechanisms that specify which sustainability outcomes are expected and how trade-offs are managed. This is especially important given that governance oriented constructions (e.g., accountability and outcome evaluation) appear less central in the high-frequency conceptual core at the applied threshold, indicating potential blind spots in how innovation-for-sustainable-tourism debates are commonly framed.

From a capacity perspective, core periphery visibility patterns imply that knowledge diffusion may be uneven across contexts. Stakeholders in less connected contexts may face greater reliance on imported models and framings. Strengthening cross context collaboration, improving methodological transparency, and embedding outcome measurement into innovation initiatives can support learning and reduce the risk of adopting technology without a clear evaluation architecture.

7. Conclusion and future research

This study mapped the knowledge base on technological innovation for sustainable tourism using Scopus indexed journal articles published between 2010 and 2023 (N = 1,044) and interpreted the field through a knowledge production bias and governance lens. The results show substantial growth of the domain over time and a conceptual structure in which smart/digital/AI-related narratives are embedded within broad sustainability framings. Collaboration networks further indicate a visible core-periphery structure, while bias diagnostics reveal measurable concentration of output and citation influence within a relatively narrow set of contributors in the mapped collaboration space.

The paper's contribution lies in shifting bibliometric evidence from descriptive mapping to diagnostic interpretation. Specifically, it (i) quantifies concentration and collaboration visibility patterns that indicate uneven agenda visibility within the mapped network, and (ii) identifies thematic dominance patterns and potential blind spots where governance oriented constructs appear less central in the high frequency conceptual core at the applied threshold. Importantly, these insights are bounded to publication metadata and mapped network structures rather than direct measures of destination performance or policy readiness. The retrieval validation (precision estimate = 74.0%), complemented by a two coders agreement check, provides an additional boundary condition that strengthens confidence in scope decisions while underscoring the need to account for false positives in bibliometric workflows.

Future research should extend mapping beyond 2023 and test robustness through alternative retrieval strategies (e.g., expanded query operationalisation or multi-database designs) and sensitivity checks on mapping thresholds and counting methods. Equally important, metadata-based diagnostics should be complemented by qualitative or mixed-method synthesis to examine how governance and measurement constructs are operationalised in high-impact streams, and whether the relationship between innovation mechanisms and sustainability outcomes is supported by empirical evidence. Comparative studies across contexts can further clarify how collaboration visibility and institutional capacity shape the diffusion of innovative narratives and their translation into measurable sustainability outcomes.

Declarations

Author Contribution

Khalaf Al Bahri. led the study conception and execution, including search design, data retrieval and deduplication, bibliometric analysis, and drafting of the manuscript. Aza Azlina provided academic supervision across all stages, including methodological guidance, critical review of the study design and interpretation, and substantive revisions to strengthen theoretical and practical contributions. Aza Azlina also served as an independent second coder for the retrieval validation (two-coder check), reviewing inclusion/exclusion decisions for the validation sample and confirming screening consistency. Both authors reviewed and approved the final manuscript.

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Figures

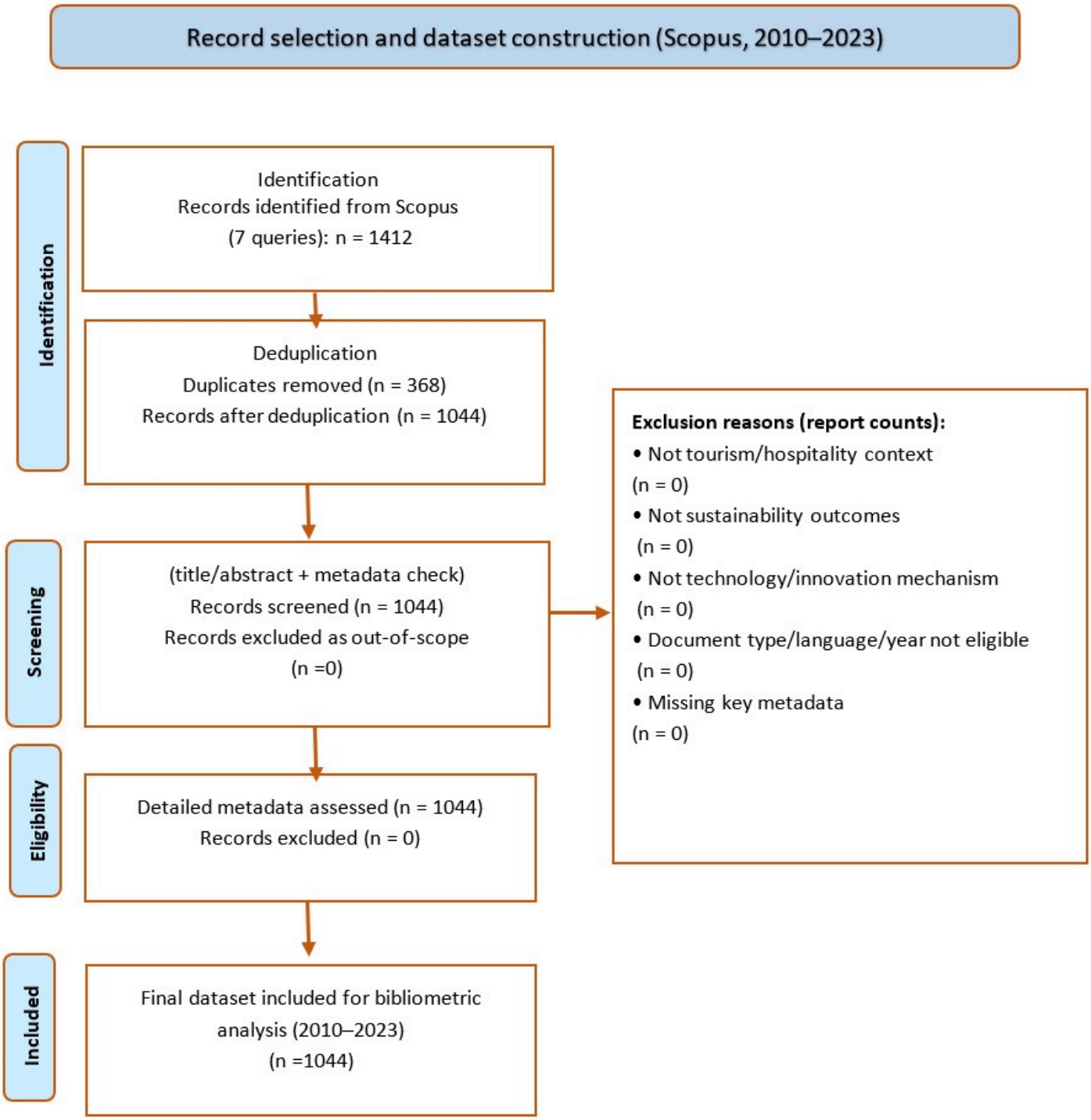


Figure 1

PRISMA 2020-style flow diagram (adapted) for Scopus record selection (2010–2023).

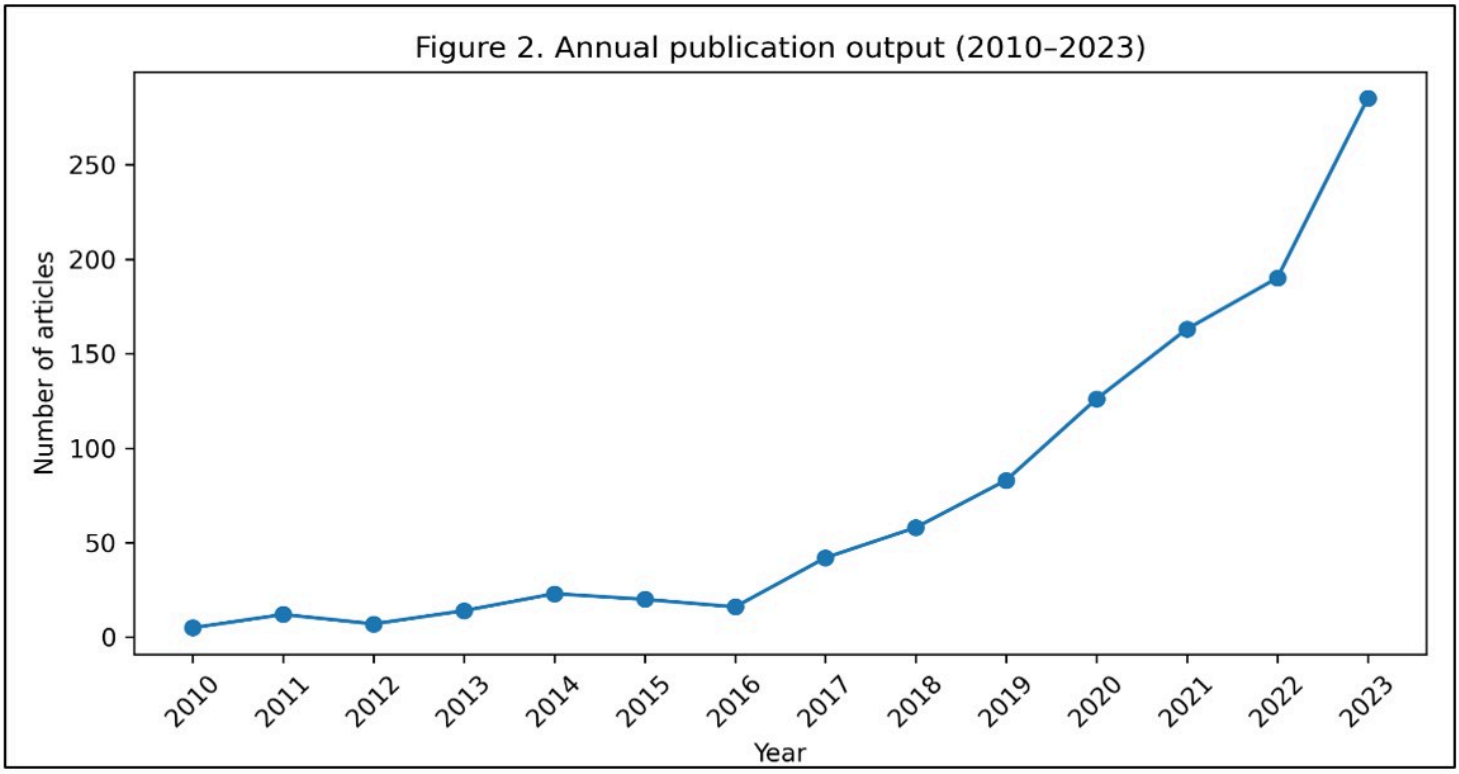


Figure 2

Annual publications (2010–2023).

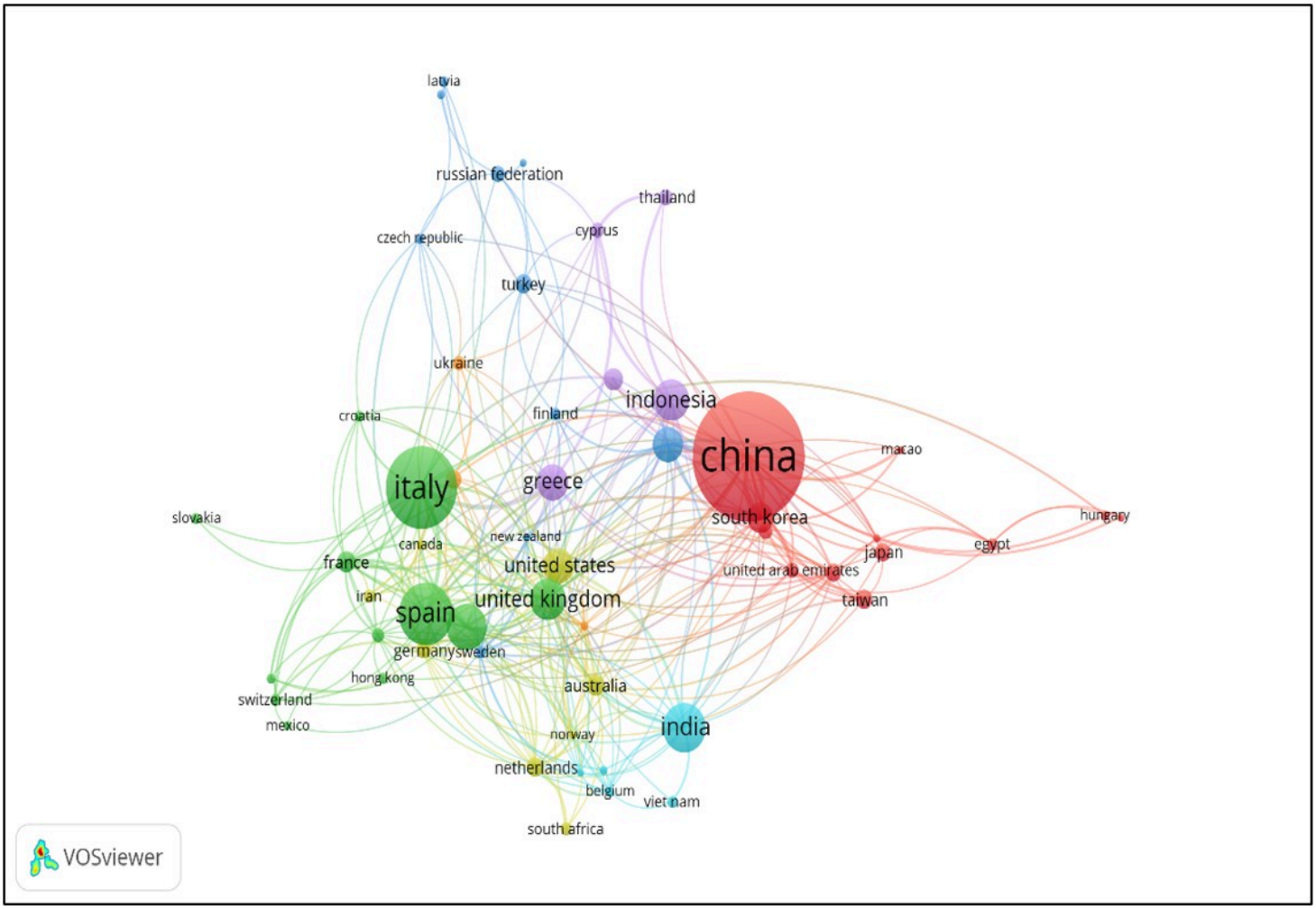


Figure 3

Country co-authorship network (VOSviewer; 2010–2023).

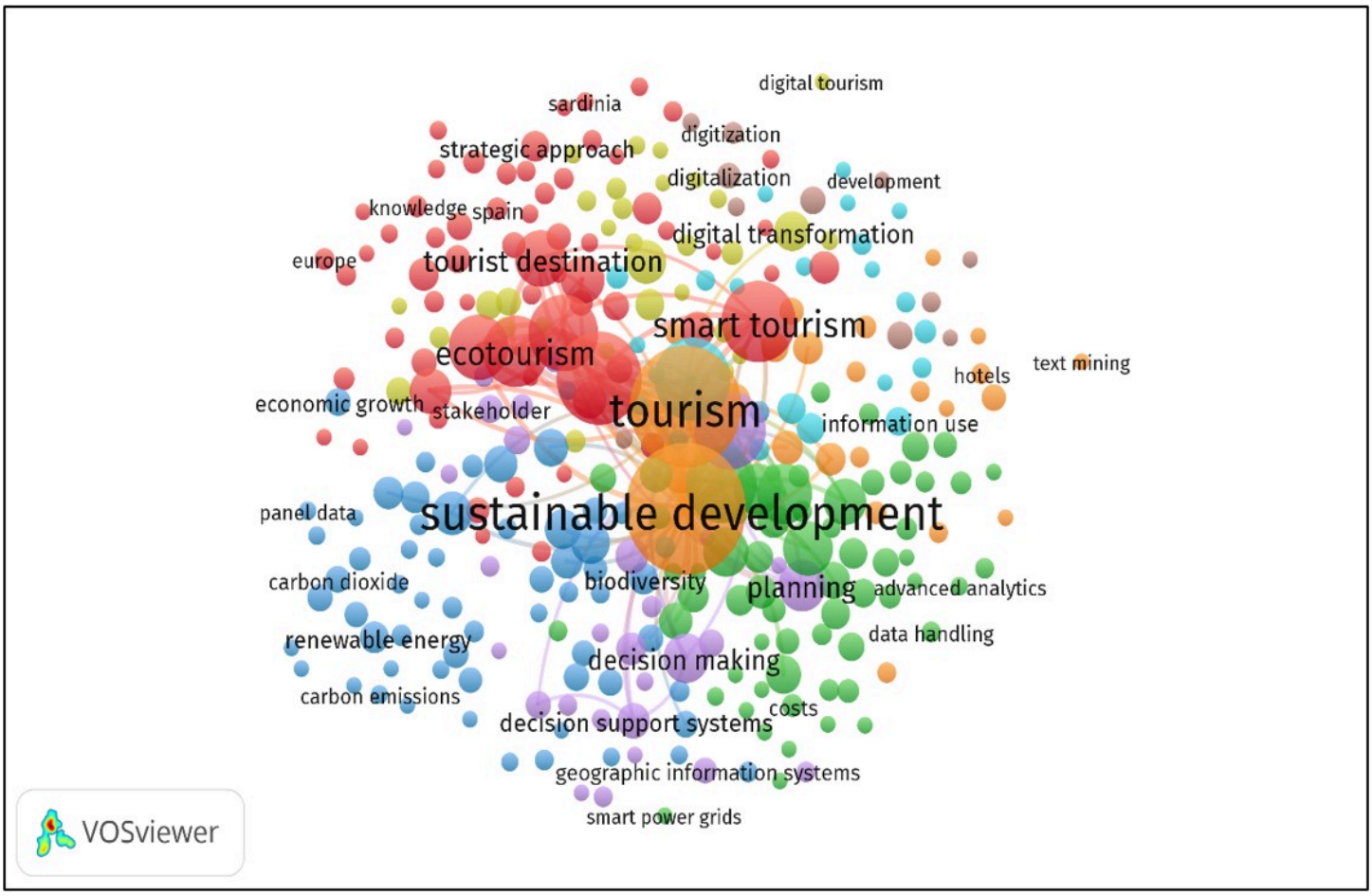


Figure 4

Keyword co-occurrence network (VOSviewer; 2010–2023).

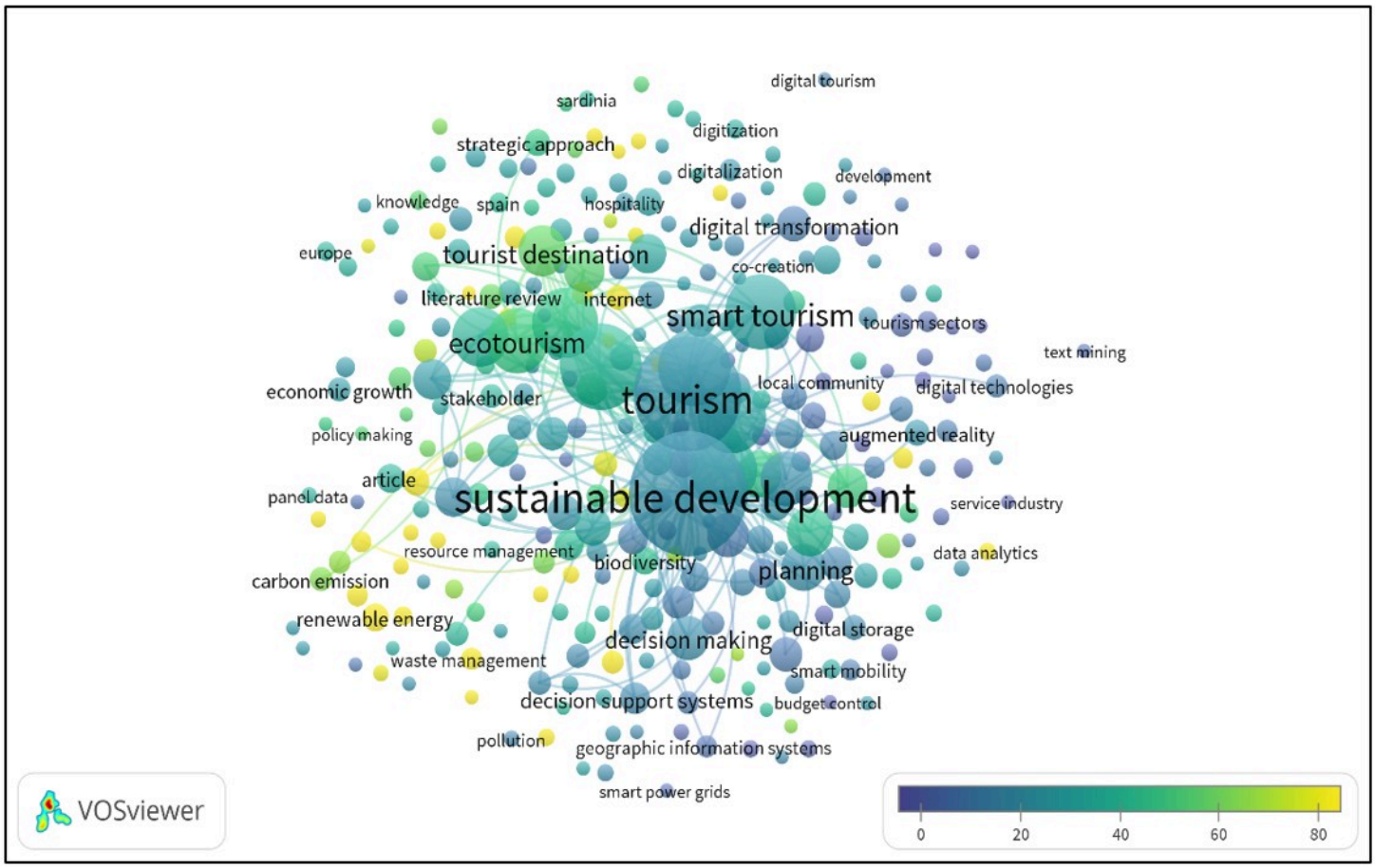


Figure 5

Overlay visualization by average publication year (VOSviewer; 2010–2023).

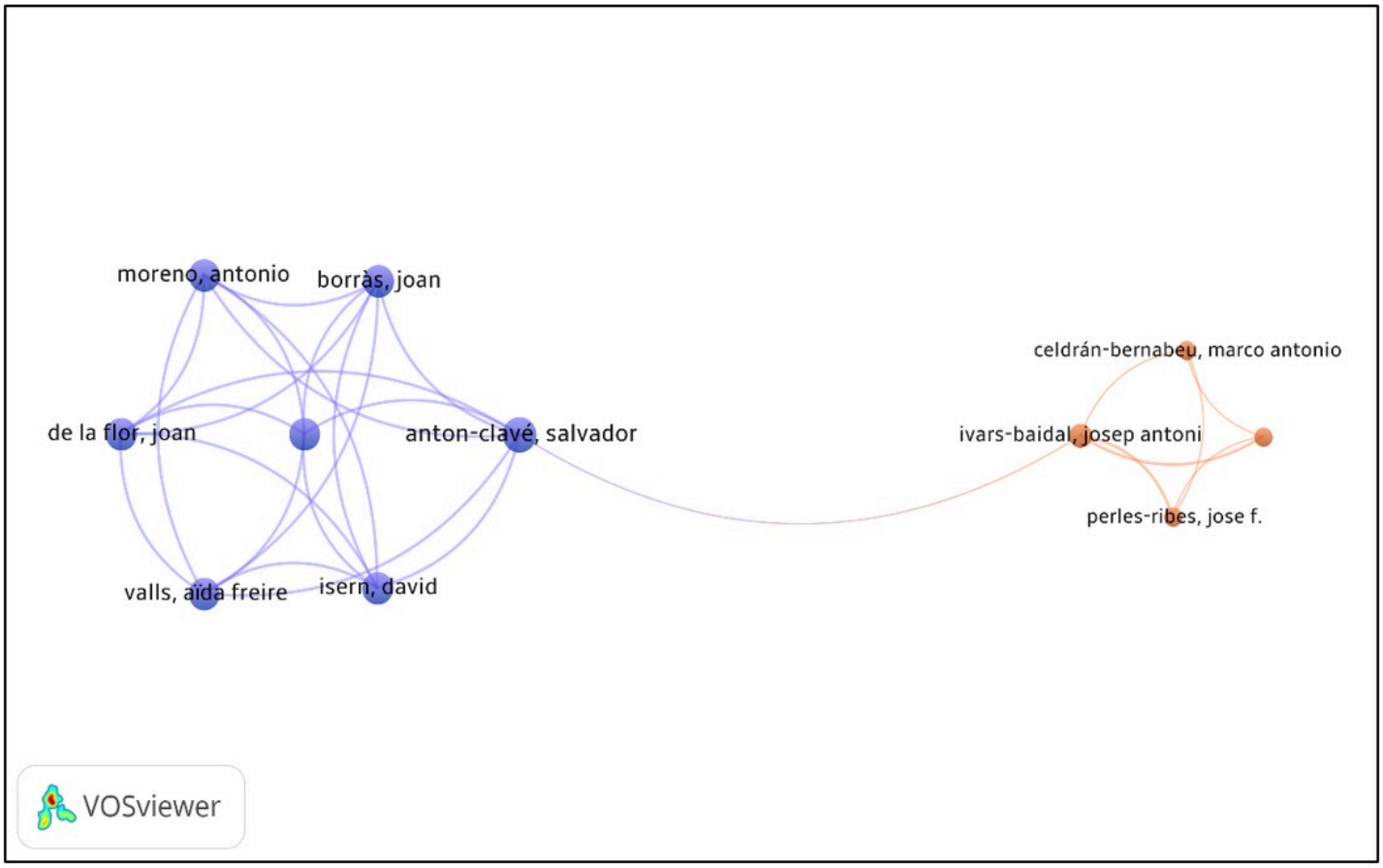


Figure 6

Author co-authorship network (VOSviewer; 2010–2023).

Supplementary Files

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- AppendixA.docx