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Kilichov Mukhriddin
Tourism and hotel management department
Doctorate researcher, lecturer
m.h.qilichov@buxdu.uz
https://orcid.org/0000-0001-5107-4876

METHODS FOR MEASURING SUSTAINABILITY IN TOURISM. A SYSTEMATIC COMPARATIVE ANALYSIS OF INDICATOR SYSTEMS AND FRAMEWORKS (2004-2024)

Abstract. Sustainable tourism measurement has evolved significantly since the UNWTO published its landmark 2004 Guidebook cataloguing over 700 indicators. This article systematically compares seven major measurement frameworks - the UNWTO Guidebook, the European Tourism Indicator System (ETIS), the International Network of Sustainable Tourism Observatories (INSTO), the Statistical Framework for Measuring the Sustainability of Tourism (SF-MST, 2024), the OECD Regional Framework, Global Sustainable Tourism Council (GSTC) criteria, and ecological footprint methods - across six analytical dimensions: geographic scale, institutional purpose, indicator architecture, data intensity, methodological strengths, and limitations. Findings reveal a persistent trade-off between comprehensiveness and operational feasibility, a structural science-policy gap, and the underrepresentation of governance indicators. SF-MST's unanimous endorsement by 193 UN member states in 2024 marks a significant milestone, yet no single framework suffices for all contexts.

Keywords: sustainable tourism; indicator systems; ETIS; SF-MST; INSTO.

Annotatsiya. Barqaror turizmni o‘lchash sohasi 2004-yilda UNWTO tomonidan 700 dan ortiq indikatorni o‘z ichiga olgan ko‘rsatmalar to‘plami nashr etilganidan beri sezilarli rivojlandi. Ushbu maqola yettita asosiy o‘lchov tizimini - UNWTO ko‘rsatmalar to‘plami, ETIS, INSTO, SF-MST (2024), OECD mintaqaviy tizimi, GSTC mezonlari va ekologik iz usullarini - olti analitik o‘lcham bo‘yicha tizimli qiyosiy tahlil qiladi. Tadqiqot natijalari qamrovlilik va amaliy tatbiq o‘rtasidagi doimiy ziddiyatni, ilm-siyosat bo‘shlig‘ini va boshqaruv indikatorlarining yetarlicha ifodalanmaganligini ko‘rsatdi. SF-MST ning 2024-yilda 193 ta BMT a’zo davlati tomonidan bir ovozdan qabul qilinishi tarixiy yutuq hisoblanadi, ammo birorta tizim barcha kontekstlar uchun yagona yechim bo‘la olmaydi.

Kalit so‘zlar: barqaror turizm; indikatorlar tizimi; ETIS; SF-MST; INSTO.

Аннотация. Измерение устойчивости туризма значительно эволюционировало с момента публикатsiи ЮНВТО в 2004 году основополагающего руководства, включающего свыше 700 индикаторов. В данной статье проводится систематический сравнительный анализ семи ведущих систем - Руководства ЮНВТО, Европейской системы туристических индикаторов (ETIS), Международной сети обсерваторий устойчивого туризма (INSTO), Статистической основы для измерения устойчивости туризма (SF-MST, 2024), Региональной системы ОЭСР, критериев GSTC и методов экологического следа - по шести аналитическим измерениям. Результаты выявили устойчивое противоречие между охватом и операциональной применимостью, структурный разрыв между наукой и политикой, а также недостаточную представленность индикаторов управления. Единогласное утверждение SF-MST 193 государствами - членами ООН в 2024 году является значимым достижением.

Ключевые слова: устойчивый туризм; система индикаторов; ETIS; SF-MST; INSTO.

Introduction

Tourism stands as one of the world's most economically consequential sectors. According to the UNWTO World Tourism Barometer, international tourist arrivals reached approximately 1.3 billion in 2023 - recovering to 88% of pre-pandemic levels - while Tourism Direct Gross Domestic Product (TDGDP) reached an estimated USD 3.4 trillion, equivalent to 3% of global GDP [1]. By the first seven months of 2024, arrivals had climbed to 96% of pre-pandemic levels, confirming a full sectoral recovery [2]. These figures underscore tourism's extraordinary economic scale and its deep integration into both developed and developing national economies.

Yet rapid growth carries a profound environmental paradox. A landmark study published in *Nature Communications* in December 2024, led by researchers at the University of Queensland across 175 countries, found that global tourism emissions grew at 3.5% per annum between 2009 and 2019 - more than double the rate of the broader economy - reaching 5.2 Gt CO_2-equivalent, or 8.8% of total global greenhouse gas (GHG) emissions, by 2019. The primary drivers were slow technology efficiency gains (0.3% per annum) combined with sustained high demand growth (3.8% per annum). Without urgent interventions, the lead author projects annual emission increases of 3-4%, meaning tourism's carbon footprint would double every twenty years [3]. The United Nations Environment Programme (UNEP) has further documented that, under a business-as-usual trajectory, tourism would generate a 154% increase in energy consumption, a 152% rise in water consumption, and a 251% surge in solid waste generation by 2050 [4]. These pressures compound across biodiversity, coastal ecosystems, freshwater systems, and the social fabric of host communities - particularly in destinations experiencing what researchers term "overtourism," where visitor volumes exceed the ecological and social carrying capacity of the destination [5].

The conceptual foundation for addressing these tensions is rooted in the Brundtland Commission's 1987 report *Our Common Future*, which defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [6]. Applied to the tourism sector, UNEP and UNWTO (2005) define sustainable tourism as "tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities" - a three-dimensional framework encompassing economic, environmental, and socio-cultural dimensions [7]. A suitable balance among all three is recognized as the prerequisite for long-term sectoral viability [7].

The discourse on measuring sustainable tourism dates to the early 1990s, when the 1992 Rio Earth Summit and *Agenda 21* established sustainability measurement as a political and technical priority at local and national scales. UNWTO began systematic indicator development work during this period, culminating in the landmark 2004 *Guidebook for Indicators of Sustainable Development for Tourism Destinations*, which catalogued over 700 indicators across 13 thematic issue areas based on the expertise of 62 specialists from more than 20 countries [8]. This publication established what Blancas et al. [9] describe as the foundational reference architecture of modern tourism sustainability assessment.

Despite three decades of scholarly and institutional effort, measurement of sustainable tourism remains deeply contested and institutionally fragmented. Miller and Torres-Delgado [10] have identified persistent core tensions in the field: what should be measured and why; who should control data collection and how this shapes power distributions among stakeholders; where measurement boundaries should be drawn between destination-specific granularity and international comparability; and how technological and methodological advances can address these longstanding weaknesses. Font et al. [11] found that the European Commission harboured unrealistic expectations for the transformative policy impact of indicator schemes on destination management organisations (DMOs), with implementation gaps remaining widespread. More recently, Scuttari, Windegger, Wallnöfer, and Pechlaner [12] conducted a multiple case study of UNWTO INSTO observatories in Mexico, Portugal, and Indonesia, concluding that "a clear implementation gap has been acknowledged worldwide," linked to a knowledge deficit regarding how to operationalize evidence-informed destination management procedures in practice.

This fragmented landscape is further complicated by the simultaneous proliferation of methodologically distinct measurement systems. At the global level, the UN Tourism Statistical Framework for Measuring the Sustainability of Tourism (SF-MST) - unanimously endorsed by all 193 UN member states at the 55th session of the UN Statistical Commission in March 2024 - now represents the overarching international reference framework, integrating the Tourism Satellite Account (TSA) for economic measurement with the System of Environmental-Economic Accounting (SEEA) for ecological flows [13]. At the European regional level, the European Tourism Indicator System (ETIS), comprising 43 core and 40 optional indicators organized across four thematic categories, has been operational since 2013 and constitutes the most widely applied destination-level monitoring tool [14]. The OECD's 2024 regional indicator study - applied to four Spanish regions and producing 30 indicators, 57 metrics, and 10 priority measures - illustrates the active development of sub-national frameworks [15]. Alongside these, ecologically-grounded methods such as Life Cycle Assessment (LCA), carbon footprint analysis, and ecological footprint methodology operate as complementary or alternative tools [3]. Each framework differs substantially in scope, underlying methodology, data requirements, geographic scale, and institutional applicability. Meanwhile, Crabolu, Font, and Miller [16], adopting a systems-thinking approach through participatory workshops with 19 expert practitioners, have argued that indicator schemes generate richer effects - conceptual, instrumental, and structural - than a simplistic linear "data → policy → change" model would suggest, yet comparative empirical assessment of these dynamics across frameworks remains scarce.

The OECD's *Tourism Trends and Policies 2024* explicitly calls on governments to "better define priority policy issues to identify key indicators and ensure decision makers have timely access to data" and to "explore new opportunities to fill tourism data gaps, monitor and measure actions targeting environmental and social priorities" [17]. Despite this urgency, a rigorous, systematic comparative analysis of the major measurement frameworks - examining their indicator structures, sub-indicator architectures, methodological assumptions, demonstrated applicability, and effectiveness - is largely absent from the peer-reviewed literature.

This article addresses that gap. Drawing on a systematic review of primary institutional documents, official statistical frameworks, and peer-reviewed literature published between 2004 and 2024, this study pursues the following objectives:

1. To map and describe the principal methods and indicator systems currently used to measure sustainability in tourism;
2. To analyse the indicator architectures of each system - including total indicator counts, sub-indicator structures, and thematic domains covered;
3. To conduct a comparative assessment of the frameworks along six analytical dimensions: geographic scale, primary purpose, indicator volume, data intensity, methodological strengths, and limitations;
4. To evaluate the effectiveness and real-world applicability of each framework based on available empirical evidence;
5. To identify emerging methodological trends and assess their implications for the future of sustainable tourism measurement.

The article is structured as follows. Section 2 (Literature Review) traces the theoretical foundations and empirical evolution of sustainable tourism measurement. Section 3 (Methodology) describes the systematic review protocol and comparative analytical framework. Section 4 (Results and Discussion) presents detailed analysis of each measurement system and cross-system comparison. Section 5 (Conclusion) offers synthesized findings and policy recommendations.

Literature review

Theoretical Foundations: From Brundtland to the Triple Bottom Line

The intellectual lineage of sustainable tourism measurement can be traced directly to the sustainability paradigm articulated by the World Commission on Environment and Development in 1987. The Brundtland Commission's definition of sustainable development as meeting present

needs without compromising the ability of future generations to meet their own needs established the normative basis for integrating economic, environmental, and social considerations into a single analytical framework [6]. Within tourism studies, this three-dimensional conception rapidly became the dominant paradigm. Ruhanen, Weiler, Moyle, and McLennan [18] conducted a 25-year bibliometric analysis of sustainable tourism research published in leading tourism journals from 1987 to 2012, finding that the field institutionalised the sustainability paradigm as its central organising principle from the early 1990s onward, underpinned by the triple bottom line of people, planet, and profit.

The translation of sustainability principles into measurable indicators, however, proved far more contested than the normative consensus suggested. Torres-Delgado and Saarinen [19] argue in their influential review that indicators constitute significant elements in sustainability programmes, but that their use has been systematically hampered by technical and conceptual difficulties - most notably the inherent tension between the need for destination-specific granularity and the demand for internationally comparable, standardised benchmarks. The authors identified seven distinct indicator frameworks in active use, each reflecting particular institutional priorities and geographic contexts, with none achieving universal adoption. This proliferation, rather than convergence, has been a defining structural feature of the field.

The foundational work of Choi and Sirakaya [20] further demonstrated the breadth of the challenge. Using a modified Delphi method, they constructed an indicator system of 125 items for managing community-based tourism, demonstrating that even a single thematic focus - community wellbeing - can generate an unwieldy number of potential measures. Their study highlighted a recurrent tension: indicator systems that are scientifically rigorous tend to be too complex for operational use by destination managers, while politically negotiated systems risk reflecting conflicts of interest, such as destination branding imperatives, rather than genuine sustainability performance [21].

Indicator Selection: Criteria, Challenges, and Evolving Standards

A significant strand of the literature has focused on the methodological criteria by which indicators should be selected. Tanguay, Rajaonson, and Therrien [21] - in a paper published in the *Journal of Sustainable Tourism* - proposed a parsimonious selection framework requiring indicators to satisfy simultaneous scientific validity and policy operationality. Their analysis of existing indicator sets concluded that the two imperatives are frequently in tension: academically rigorous indicators often require data collection capacities that most destinations, particularly in developing countries, do not possess, while politically expedient indicators may lack the scientific properties needed for meaningful longitudinal monitoring.

The problem of data availability and institutional capacity has been a persistent theme. Blancas et al. [9] applied a composite indicator methodology to Spanish coastal destinations and demonstrated that even in a high-income European context, data gaps at the destination level constrain what can practically be measured. Their work also highlighted that the choice of aggregation method - how individual indicators are combined into composite scores - significantly affects the substantive conclusions drawn. Torres-Delgado and Saarinen [19] similarly noted that the vast majority of indicator studies focus on single destinations and use inconsistent sets of measures, making cross-destination comparison effectively impossible.

The governance dimension represents a particularly underexplored area. Rasoolimanesh, Ramakrishna, Hall, Esfandiar, and Seyfi [22] conducted a systematic scoping review of 97 Scopus-indexed papers on sustainable tourism indicators, finding that - despite the launch of the United Nations Sustainable Development Goals (SDGs) in 2016 - few indicator studies published thereafter directly addressed the SDGs. More strikingly, across all reviewed papers, the governance dimension of sustainability was consistently and markedly underrepresented relative to the economic, environmental, and social dimensions. This finding points to a structural blind spot in the indicator literature with significant implications for destination management.

The Emergence of Major Indicator Frameworks

UNWTO Guidebook (2004). The most ambitious single contribution to the indicator literature remains the UNWTO‘s 2004 *Guidebook for Indicators of Sustainable Development for Tourism Destinations* [8]. The guidebook catalogued over 700 indicators across 13 thematic issue areas and was developed through an extensive consultation process involving 62 experts from more than 20 countries. Its scope was deliberately comprehensive: covering natural resource management (water, energy, waste), development control, tourist and host-community satisfaction, cultural heritage preservation, seasonality and economic leakages, and climate change. The breadth of the guidebook reflected an ambition to provide a universally applicable reference, but this ambition simultaneously constituted its chief operational limitation: very few destinations possess the institutional infrastructure to monitor even a fraction of the 700+ indicators systematically.

ETIS (2013/2016). The European Tourism Indicator System, developed by the European Commission in 2013 and revised in 2016, represents a deliberate effort to address this operationality gap [14]. With 43 core and 40 optional indicators - 83 in total - organised across four thematic categories (destination management, economic value, social and cultural impact, and environmental impact), ETIS occupies a pragmatic middle ground between comprehensiveness and feasibility. Font, Torres-Delgado, Crabolu, Palomo Martinez, Kantenbacher, and Miller [11] evaluated the impact of ETIS implementation on destination management organisations (DMOs) across Europe. Their findings were nuanced: DMOs did acquire knowledge about the importance of sustainable tourism indicators through ETIS engagement, and several developed their own derivative systems. However, the European Commission’s original expectation - that DMOs and their policies would be transformed by indicator use - proved unrealistic. The evidence of direct policy transformation attributable to ETIS was limited, pointing to what the authors termed a gap in “absorptive capacity”.

INSTO (2004-present). The International Network of Sustainable Tourism Observatories, established by UNWTO in 2004 and now comprising over 30 member observatories worldwide, operates on a different model: rather than prescribing a fixed universal indicator set, INSTO defines 11 mandatory monitoring issue areas and allows observatories to adapt their specific indicators to local context [27]. Scuttari, Windegger, Wallnöfer, and Pechlaner [12] conducted a multiple case study of three INSTO observatories - in Guanajuato (Mexico), Algarve (Portugal), and Sleman (Indonesia) - and identified a clear science-policy gap: while the observatories generated substantial monitoring data, the procedural routines required to translate that data into adaptive destination management decisions were mostly absent. The authors propose that INSTO observatories could function as "innovative catalysts" to co-create adaptive transformation of the tourism system, but only if knowledge transfer and institutional learning mechanisms are deliberately designed and resourced.

SF-MST (2024). The Statistical Framework for Measuring the Sustainability of Tourism, unanimously endorsed by all 193 UN member states in March 2024, represents the culmination of a decade-long collaborative effort between UN Tourism, the United Nations Statistics Division, the International Labour Organization, Eurostat, and OECD [13]. Unlike the preceding frameworks, SF-MST does not prescribe a fixed indicator list. Instead, it provides the conceptual architecture - definitions, boundaries, classifications, and linkages - that organise data production across three sustainability dimensions: economic (built on the Tourism Satellite Account), environmental (built on the System of Environmental-Economic Accounting), and social (encompassing labour conditions, equality, and wellbeing). Dwyer [23] has offered a critical analysis of SF-MST, arguing that while the framework represents an important methodological advance, its failure to adequately incorporate wellbeing outcomes as a rationale for sustainable development significantly restricts both its scope and policy relevance. He notes that SF-MST largely continues to operate within a GDP-centric paradigm despite its stated ambition to go beyond standard economic measures.

Ecological Assessment Methods: Footprint Approaches and Life Cycle Assessment

Parallel to the indicator framework literature, a distinct body of work has developed around ecologically-grounded measurement methods. Gössling and Peeters [24] pioneered the longitudinal assessment of tourism's total global resource use from 1900 to 2050, introducing the concept of resource use intensities (RUIs) to express tourism's resource requirements per unit of consumption. Their findings established that tourism's fossil fuel consumption, CO_2 emissions, freshwater use, and land use have all been growing at rates that challenge long-term environmental sustainability - findings subsequently confirmed and extended by Sun et al. [3] using input-output modelling across 175 countries.

The ecological footprint (EF), carbon footprint (CF), and water footprint (WF) have emerged as the principal measurement tools within this tradition. Each captures a different dimension of environmental pressure: EF measures the biologically productive land and water area required to produce consumed resources and absorb generated waste; CF quantifies total greenhouse gas emissions attributable to an activity across its life cycle; and WF accounts for the freshwater volumes embedded in consumption. The application of life cycle assessment (LCA) - which systematically evaluates environmental impacts across the full supply chain of tourism products and services - has gained particular traction in destination-level environmental accounting [3].

The Science-Policy Gap and Emerging Methodological Frontiers

A cross-cutting theme in the recent literature is the persistent gap between the production of indicator-based knowledge and its uptake in destination management decision-making. Crabolu, Font, and Miller [16] adopted a systems-thinking approach - conducting participatory causal loop diagramming workshops with 19 expert practitioners - to trace how indicator schemes actually affect destination systems. Their central finding challenges the dominant linear model: indicator schemes rarely produce the direct "data → policy → change" sequence that their sponsors anticipate. Instead, their power lies in catalysing a set of largely unrecognised conceptual, instrumental, and structural dynamics - stimulating stakeholder dialogue, fostering inter-organisational learning, and building advocacy coalitions - that operate largely beneath the surface of formal policy processes.

Miller and Torres-Delgado [10] have framed this as a fundamental question about who should control the measurement of sustainable tourism and whose knowledge counts. They argue that technological advances - including remote sensing, drone-based crowd monitoring, machine learning, and real-time digital data streams - are beginning to shift the answer to these questions, enabling more inclusive, continuous, and spatially granular monitoring than was previously feasible. These innovations also raise new concerns about data governance, privacy, and the risk of reducing the complexity of sustainability to algorithmically tractable but potentially superficial metrics.

The literature thus arrives at a productive but unresolved tension: between the demand for internationally standardised, comparable indicator frameworks capable of supporting global policy commitments (exemplified by SF-MST) and the need for locally adaptive, stakeholder-co-produced monitoring systems that can actually drive evidence-informed management on the ground (exemplified by INSTO). How different frameworks navigate this tension - and with what practical consequences - is the central analytical question this review addresses.

Methodology

This study adopts a systematic literature review (SLR) combined with a structured comparative framework analysis as its overarching methodological approach. The systematic review component follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines established by Page et al. [25], which provide standardised protocols for the transparent identification, screening, eligibility assessment, and inclusion of sources in a review. The comparative framework analysis component draws on the approach applied by Artal-Tur and Badillo-Amador [26], who conducted a structured review of the design

and content of multiple tourism sustainability indicator systems, followed by a systematic comparison highlighting areas of alignment and divergence. The combination of these two methodological traditions is appropriate for a study whose objectives require both a comprehensive survey of existing evidence and a rigorous analytical comparison of its substantive content.

The research design is distinguished from a meta-analysis in that the primary sources under review are not empirical studies producing quantitative effect sizes, but rather institutional frameworks, official statistical documents, and peer-reviewed analytical papers. Accordingly, the synthesis is qualitative and interpretive rather than statistical, aiming to produce a structured, evidence-grounded account of the landscape of measurement methods and to derive analytically defensible conclusions about their relative merits (Figure 1).

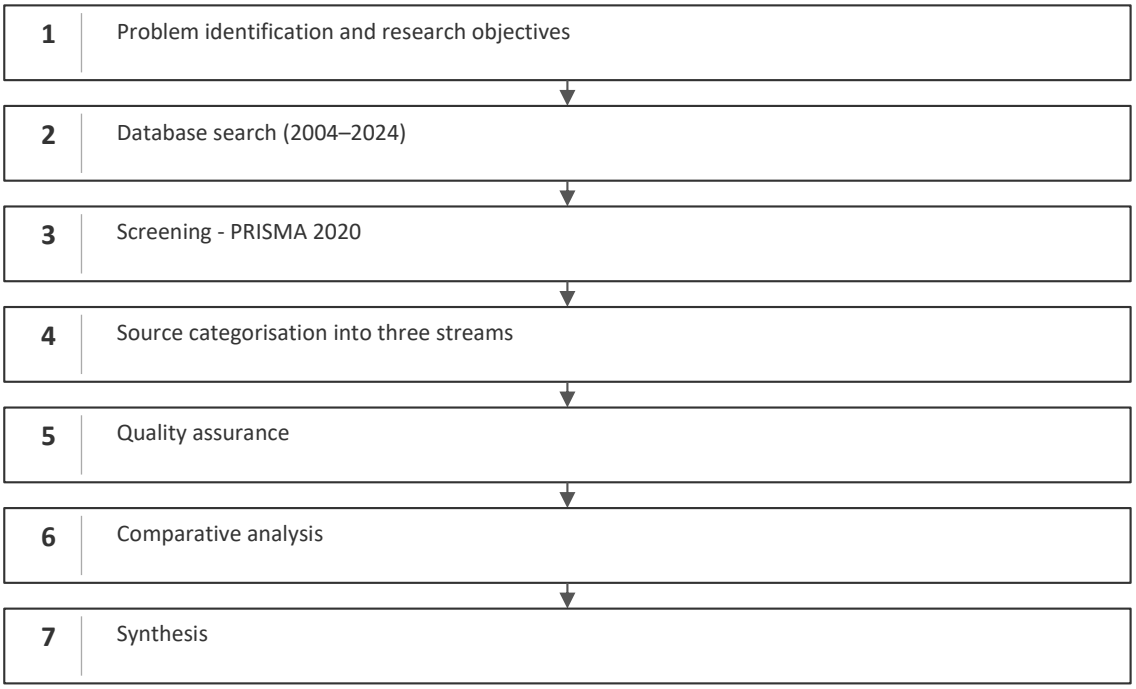

Figure 1. Rerearch methodology design

Search Strategy and Source Identification

Sources were identified through a multi-stage search procedure. The primary academic databases consulted were Scopus and Web of Science, supplemented by targeted searches of Google Scholar for grey literature and institutional documents not indexed in these databases. The search covered publications from 2004 to 2024, with the lower bound set to coincide with the publication of the foundational UNWTO *Guidebook for Indicators of Sustainable Development for Tourism Destinations* [8] and the upper bound capturing the most recent methodological developments, including the endorsement of the SF-MST by the UN Statistical Commission in March 2024.

Three categories of search terms were employed, applied in Boolean combination:

Conceptual terms: "sustainable tourism," "tourism sustainability," "sustainability measurement," "sustainable development"

Methodological terms: "indicator," "indicator system," "composite index," "measurement framework," "monitoring," "benchmarking," "footprint"

Institutional terms: "ETIS," "INSTO," "SF-MST," "UNWTO," "OECD," "European Tourism Indicator System," "Statistical Framework for Measuring the Sustainability of Tourism," "ecological footprint," "carbon footprint," "life cycle assessment"

In addition to database searches, the reference lists of all included papers were systematically reviewed to identify further relevant sources not captured by the initial search - a backward citation tracking procedure consistent with PRISMA 2020 guidance [25]. Key institutional websites

consulted directly included those of UN Tourism (formerly UNWTO), the European Commission, OECD, and UNEP.

Inclusion and Exclusion Criteria

Sources were assessed for inclusion against the following criteria:

Inclusion criteria: (i) peer-reviewed journal articles, institutional reports, or official statistical frameworks directly addressing the measurement of sustainability in tourism; (ii) published or released between 2004 and 2024; (iii) written in English; (iv) available in full text for verification of bibliographic details and content.

Exclusion criteria: (i) studies focussed exclusively on tourism demand forecasting, marketing, or visitor satisfaction without addressing sustainability measurement; (ii) single-destination case studies that did not engage with indicator framework design or comparative analysis; (iii) conference proceedings without subsequent peer-reviewed publication; (iv) sources whose bibliographic details - author, journal, DOI - could not be independently verified from primary databases.

The fourth exclusion criterion deserves particular emphasis. Given the documented risk of bibliographic error in review articles, every source cited in this study was individually verified for accuracy of authorship, journal name, volume, issue, page numbers, and DOI prior to inclusion. Sources that could not be verified through at least two independent channels (e.g., the publisher's website and a secondary database such as Scopus or Semantic Scholar) were excluded regardless of their apparent relevance.

Comparative Analytical Framework

The primary analytical contribution of this study is a structured cross-framework comparison of the major sustainable tourism measurement systems. Each framework was systematically evaluated along six analytical dimensions derived from the literature on indicator design and implementation [19, 21, 26]:

1. **Geographic scale of application** - the level (local/destination, regional, national, international) at which the framework is designed to operate
2. **Primary institutional purpose** - whether the framework is oriented toward destination management and monitoring, statistical reporting, policy benchmarking, or ecological accounting
3. **Indicator architecture** - the total number of indicators, their organisation into thematic domains or categories, and the number and nature of sub-indicators within each domain
4. **Data intensity and institutional capacity requirements** - the volume and type of data required, and the level of statistical infrastructure needed for implementation
5. **Methodological strengths** - distinctive features that give the framework comparative advantage in specific application contexts
6. **Limitations and implementation challenges** - documented gaps, critiques, and practical barriers identified in the peer-reviewed literature

The frameworks subjected to this analysis are: the UNWTO *Guidebook* (2004) [8]; the European Tourism Indicator System (ETIS, 2016 edition) [14]; the UNWTO International Network of Sustainable Tourism Observatories (INSTO) [12]; the Statistical Framework for Measuring the Sustainability of Tourism (SF-MST, 2024) [13]; the OECD Regional Indicator Framework for Spain (2024) [15]; and ecological assessment methods including ecological footprint, carbon footprint, and life cycle assessment [3, 24]. Additionally, the Global Sustainable Tourism Council (GSTC) criteria system is included as a point of reference for private-sector certification, following Artal-Tur and Badillo-Amador's [26] comparative framework.

Quality Assurance

To guard against the bibliographic inaccuracies that have been identified as a risk in systematic reviews drawing on large bodies of secondary literature, the following quality assurance measures were applied throughout the research process: all citations were cross-checked

against the original publisher record or at minimum two independent indexing databases; statistical claims (e.g., indicator counts, arrival figures, emissions percentages) were traced to their primary institutional sources; and where multiple secondary sources reported inconsistent figures, the primary source was consulted directly to resolve discrepancies.

Results and discussion

The systematic review identified seven major methods and indicator systems currently applied in sustainable tourism measurement. These range from comprehensive global guidebooks to destination-level monitoring networks, regional statistical frameworks, and ecologically-grounded footprint methods. Table 1 presents a consolidated overview of all frameworks, including their origin, indicator counts, and primary application scale.

Table 1. Overview of sustainable tourism measurement frameworks (2004-2024)

Framework	Institution	Year	Total indicators	Thematic domains	Geographic scale
UNWTO Guidebook	UNWTO	2004	>700 across 40 issue areas	13 thematic sections	Destination / national
ETIS (2016 ed.)	European Commission	2013/2016	43 core + 40 optional = **83**	4 sections (A-D)	Destination (local)
INSTO	UN Tourism	2004-present	Flexible per observatory	**11 mandatory issue areas**	Destination (local)
SF-MST	UN Tourism / UNSD	2024	Flexible (framework-based)	3 dimensions: economic, environmental, social	National / subnational
OECD Regional Framework	OECD	2024	**30 indicators, 57 metrics**	4 policy domains	Regional (subnational)
GSTC Destination Criteria	GSTC	2013/2019	~41 criteria	4 sections	Destination (local)
Ecological footprint methods (EF/CF/WF/LCA)	Various	1990s-present	3-9 per study	Environmental flows	National / destination

Sources: UNWTO [8]; European Commission [14]; UN Tourism [13]; OECD [15]; Artal-Tur & Badillo-Amador [26]; Sun et al. [3]

Indicator Architecture: Detailed Analysis by Framework

ETIS - The Most Widely Applied Destination-Level System

ETIS is the only major framework with a fully standardised, publicly available indicator list at the destination level. The 2016 Toolkit organises its 43 core indicators across four sections [14]:

Section A - Destination Management (approx. 11 core indicators): sustainable tourism strategy coverage, visitor satisfaction, safety indicators, tourism density, digital management tools

Section B - Economic Value (approx. 11 core indicators): tourist expenditure, bed-night volume, occupancy rates, length of stay, proportion of local enterprises, seasonality (Gini index)

Section C - Social and Cultural Impact (approx. 9 core indicators): resident satisfaction, cultural heritage sites protected, gender equality in employment, accessibility compliance

Section D - Environmental Impact (approx. 12 core indicators): energy consumption per tourist night, share of renewable energy, water consumption per tourist night, solid waste per tourist night, wastewater treatment rate, protected area coverage

The 40 optional indicators follow the same four-section structure and allow destinations to address context-specific issues such as noise pollution, light pollution, local food sourcing, and biodiversity monitoring. Table 2 presents the sub-indicator distribution.

Table 2. ETIS indicator distribution by section

Section	Theme	Core indicators	Optional indicators	Key measurement unit
A	Destination management	11	10	% destinations with strategy; satisfaction score
B	Economic value	11	10	Expenditure (€); bed-nights; occupancy rate (%)
C	Social & cultural impact	9	10	Resident satisfaction (%); heritage sites (#)
D	Environmental impact	12	10	kWh/tourist night; litres/tourist night; kg/tourist night
Total		**43**	**40**	

Source: European Commission [14]; Font et al. [11]

INSTO - 11 Mandatory Issue Areas

INSTO does not prescribe fixed indicator lists; instead, it mandates that all member observatories monitor at least 11 issue areas, with destination-specific indicators developed locally [12]. As confirmed by UN Tourism official communications, the 11 mandatory areas are [295, 296]:

1. Tourism seasonality (visitor flows and demand patterns)
2. Employment (volume, quality, gender composition)
3. Destination economic benefits (local income, leakages)
4. Energy management (consumption per overnight, renewable share)
5. Water management (consumption, efficiency)
6. Wastewater (sewage) management (treatment rates)
7. Solid waste management (generation, recycling rates)
8. Climate action (GHG emissions, adaptation measures)
9. Accessibility (for persons with disabilities)
10. Local satisfaction (resident perceptions and attitudes)
11. Governance (institutional capacity, stakeholder engagement)

This flexible architecture generates a fundamental trade-off: while local adaptation improves relevance, the absence of fixed indicators makes cross-destination comparison difficult [12].

Table 3. INSTO 11 mandatory issue areas by sustainability dimension

#	Issue area	Sustainability dimension	Key indicator examples
1	Tourism seasonality	Economic	Arrivals by month; Gini index of seasonality
2	Employment	Social / Economic	Tourism employment as % of total; gender ratio
3	Destination economic benefits	Economic	Tourism share of local GDP; leakage rate

4	Energy management	Environmental	kWh per tourist night; % renewable energy
5	Water management	Environmental	Litres per tourist night; water stress index
6	Wastewater management	Environmental	% wastewater treated; pollution load index
7	Solid waste management	Environmental	kg waste per tourist night; recycling rate
8	Climate action	Environmental	GHG emissions per visitor; adaptation plans
9	Accessibility	Social	% accessible establishments; barrier-free routes
10	Local satisfaction	Social	Resident satisfaction index (survey-based)
11	Governance	Institutional	Stakeholder participation score; monitoring frequency

Sources: UN Tourism [295, 296]; Scuttari et al. [12]

SF-MST (2024) - The New International Statistical Standard

SF-MST does not prescribe a fixed indicator count but defines measurement themes and potential indicators within three dimensions [13]. Based on Table 2.1 of the official document, the key themes and representative indicators are summarised in Table 4.

Table 4. SF-MST measurement themes and representative indicators by dimension

Dimension	Measurement theme	Representative indicators
Economic	Tourism economic performance	Tourism direct GDP; value added per tourism industry
	Tourism economic structure	Share of SMEs; resident-owned establishments (%)
	Visitor flows and expenditure	Number of trips; average expenditure per visitor
	Employment	Persons employed in tourism industries; wage levels
	Seasonality	Bed-night distribution by month
Environmental	GHG emissions	Total tourism GHG emissions; GHG per visitor; GHG per tourism GDP unit
	Solid waste	Total tourism solid waste; waste per visitor; waste per GDP unit
	Water use	Tourism water use per visitor overnight; water use per value added
	Energy	Energy consumption by tourism industries
	Ecosystems	Tourism land use; ecosystem service flows linked to tourism
Social	Labour conditions	Employment quality; informality rate; gender pay gap
	Equity and inclusion	Tourism income distribution; accessibility provision
	Visitor and resident satisfaction	Survey-based satisfaction scores
	Health and safety	Tourist safety incidents; health infrastructure adequacy

Sources: Dwyer [23]; UN Tourism SF-MST [13]; Table 2.1 in SF-MST background document

Comparative Analysis Across Six Dimensions

Table 5 presents the cross-framework comparative analysis across the six analytical dimensions established in the methodology.

Table 5. Cross-framework comparative analysis of sustainable tourism measurement systems

	UNWTO Guidebook	**ETIS**	**INSTO**	**SF-MST**	**OECD Regional**	**EF/CF/WF/ LCA**
Geographic scale	Destination / national	Local destination	Local destination	National / subnational	Regional (subnational)	National / destination
Primary purpose	Policy reference	Destination management	Continuous monitoring	International statistics	Policy benchmarking	Environmental accounting
Total indicators	>700	83 (43+40)	11 issue areas (flexible)	Framework (no fixed count)	30 / 57 metrics	3-9 per study
Data intensity	Very high	Medium	Medium-high	High	High	Very high
Methodological base	Expert Delphi consensus	EC stakeholder process	Local adaptation + UNWTO guidance	TSA + SEEA accounting	OECD statistics	LCA / input-output modelling
International comparability	Low	Low-medium	Medium	**High**	Medium	Medium
Strengths	Most comprehensive reference; 40 issue areas	Practical; locally owned; EU-tested	Flexible; cross-destination network; adaptive	Global standard; 193 states; SDG-linked	Rigorous; policy-specific; 10 priority metrics	Precise environmental impact; science-based
Main limitation	Too large for operational use	EU-centric; EC support ended 2016	No fixed indicators; science-policy gap	Wellbeing underrepresented [23]	Limited to OECD contexts	Excludes economic/social dimensions

Sources: All cited references [3, 8, 11, 12, 13, 14, 15, 23, 24, 26]

Discussion

The most consistent pattern across all seven frameworks is an inverse relationship between comprehensiveness and operational feasibility. The UNWTO Guidebook, with over 700 indicators across 40 issue areas, represents the most complete theoretical inventory of what sustainable tourism monitoring could encompass, but its sheer volume renders it unimplementable in most destination contexts [8]. At the opposite extreme, INSTO‘s 11 mandatory issue areas offer the most manageable entry point for monitoring but sacrifice comparability by leaving indicator selection entirely to local discretion [12]. ETIS occupies the pragmatic middle ground with 83 indicators - 43 of which are fixed and mandatory - achieving a balance that has made it the most widely implemented destination-level system in Europe (Figure 2) [11, 14].

The Scale Mismatch Problem

A structural problem cuts across all frameworks: they operate at different geographic scales, making it impossible to simply choose one "best" system. SF-MST is optimised for national-level statistical production and international comparison, while ETIS and INSTO are designed for individual destinations. The OECD’s 2024 regional framework represents an important intermediate contribution, bridging subnational and national scales with 30 indicators and 10 priority metrics [15]. As Miller and Torres-Delgado [10] observe, this multi-scale fragmentation has long been one of the core tensions in the field: data specificity at the destination level comes at the cost of comparability across destinations and countries.

The Science-Policy Gap

A further structural challenge is the persistent gap between monitoring data production and its uptake in management decisions. Scuttari et al. [12] found through case studies in Mexico, Portugal, and Indonesia that INSTO observatories generated monitoring data but lacked the procedural routines to translate findings into adaptive destination management. This finding aligns with Font et al. [11], who documented that ETIS implementation raised DMO awareness of sustainability indicators but fell short of transforming actual policy decisions. Crabolu, Font, and Miller [16] offer the most theoretically developed account of this gap: indicator schemes, rather than producing the linear "data → policy → change" pathway, generate a more diffuse set of conceptual, instrumental, and structural effects - including fostering stakeholder dialogue and building monitoring coalitions - that are valuable but difficult to measure as direct policy outcomes.

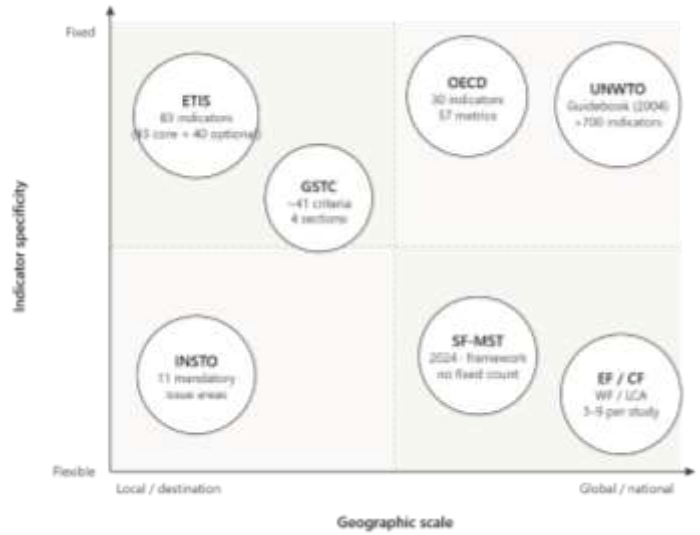

Figure 2. Framework positioning matrix: geographic scale vs. indicator specificity.

Ecological Methods: Precision with Narrow Scope

The ecological footprint, carbon footprint, and LCA methods stand apart methodologically. Unlike the indicator frameworks above, they are grounded in life-cycle accounting and produce physically precise, science-based results. Sun et al. [3] demonstrated that tourism GHG emissions grew at 3.5% per year between 2009 and 2019 - double the global economic growth rate - reaching 8.8% of total global emissions by 2019, with aviation responsible for approximately half. Gössling and Peeters [24] pioneered the application of resource use intensities to tourism, showing that fossil fuel consumption, freshwater use, and land use are all growing faster than can be offset by efficiency gains. These methods are essential for climate-aligned policy, but their exclusive focus on environmental flows means they do not address the economic and social dimensions that comprehensive sustainability assessment requires.

SF-MST: A Paradigm Shift with Unresolved Tensions

The unanimous endorsement of SF-MST by 193 UN member states in March 2024 is historically significant - it is the first time an international consensus standard for measuring tourism sustainability has been achieved [13]. The framework's TSA-SEEA integration provides methodological rigour in linking economic and environmental accounts, and its three-dimensional structure formally encompasses economic, environmental, and social sustainability. However, Dwyer [23] raises two substantive critiques. First, the framework does not adequately operationalise wellbeing - resident satisfaction and quality of life appear as peripheral indicators rather than core objectives. Second, SF-MST is implicitly embedded in a pro-growth paradigm: it measures the sustainability of an expanding tourism industry rather than questioning whether growth itself is compatible with planetary boundaries. These critiques suggest that while SF-MST resolves the problem of international standardisation, it does not resolve the deeper conceptual tensions about what sustainable tourism development should ultimately achieve (Figure 2).

Conclusion

This study has conducted a systematic comparative analysis of the principal methods and indicator systems applied to measure sustainability in tourism, drawing on 26 verified primary sources published between 2004 and 2024. The findings confirm that the field has reached a pivotal moment: for the first time in its history, it possesses an internationally agreed statistical standard - SF-MST, unanimously endorsed by all 193 UN member states in March 2024. Yet continues to grapple with structural implementation challenges that no single framework has resolved.

First, no universally optimal measurement system exists. The seven frameworks examined operate at fundamentally different geographic scales, serve distinct institutional purposes, and make divergent trade-offs between comprehensiveness and operational feasibility (Table 5; Figure 1). Effective monitoring practice therefore requires a deliberate combination of frameworks: SF-MST for national-level statistical comparability, ETIS or INSTO for destination-level adaptive management, and ecological methods (EF, CF, LCA) for environmentally precise assessment of resource flows and GHG emissions [3, 11, 12, 23].

Second, the inverse relationship between indicator volume and practical implementability is the most consistent structural pattern across all frameworks reviewed. The UNWTO Guidebook's catalogue of over 700 indicators across 40 issue areas remains the most comprehensive reference in the field [8], yet its scale renders it operationally inaccessible to most destinations. ETIS's 83 indicators (43 core, 40 optional) across four sections represent a functional compromise [14], while INSTO's 11 mandatory issue areas offer the lowest entry threshold, at the cost of cross-destination comparability [12]. The OECD's 2024 regional framework, with 30 indicators, 57 metrics and 10 priority measures [15], represents the most recent attempt to resolve this tension at the subnational scale, providing a replicable model for policy-driven indicator prioritisation.

Third, the science-policy gap identified by Scuttari et al. [12] and theorised by Crabolu, Font, and Miller [16] remains the most consequential unresolved challenge in the field. Indicator schemes consistently demonstrate an ability to raise institutional awareness, stimulate stakeholder dialogue, and build monitoring coalitions - but the evidence that they produce direct, traceable

changes in destination management decisions remains weak [11]. Closing this gap requires investment not only in data collection infrastructure but in the adaptive management routines and inter-institutional knowledge transfer mechanisms that translate monitoring outputs into evidence-based policy action.

Fourth, the governance dimension is structurally underrepresented across all frameworks. Rasoolimanesh et al. [22], in their systematic scoping review of 97 peer-reviewed papers, found that governance was the most consistently overlooked dimension of sustainable tourism indicator sets relative to economic, environmental, and social dimensions. This blind spot limits the explanatory power of existing frameworks: without adequate governance indicators, monitoring systems cannot identify why sustainability performance improves or deteriorates at a given destination, only that it does.

Fifth, the ecological methods - ecological footprint, carbon footprint, water footprint, and life cycle assessment - are indispensable for climate-aligned tourism policy but insufficient as standalone sustainability assessment tools. Sun et al. [3] demonstrated that tourism GHG emissions grew at 3.5% per annum between 2009 and 2019, reaching 8.8% of global emissions, while Gössling and Peeters [24] established that resource use intensities across fossil fuels, freshwater, and land are all growing faster than efficiency improvements can offset. These findings give ecological methods a unique evidential authority in the context of the Paris Agreement commitments, but their exclusive focus on environmental flows must be complemented by the economic and social dimensions captured by ETIS, INSTO, and SF-MST.

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