# Carbon Offsetting in Indonesia's Hospitality and Tourism Sector: Drivers, Barriers, and Strategic Pathways Toward Net Zero Emissions

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***ABSTRACT***

*The tourism industry represents a major contributor to global greenhouse gas emissions, positioning carbon offsetting as a crucial pathway toward sustainable transition. This study aims to map and synthesize the scholarly literature on carbon offsetting in Indonesia's hospitality and tourism sector, examining the extent and configuration of sectoral participation in carbon offsetting and analyzing the regulatory, economic, operational, and market-related factors that enable or constrain the adoption and scaling of carbon offsetting across the sector aligning with national net-zero emission 2060 goals. Employing a systematic literature review guided by PRISMA 2020 protocols, 30 peer-reviewed articles published between 2020 and 2025 were analyzed to ensure methodological rigor and replicability. The findings reveal that carbon offsetting practices are largely indirect and voluntary, focusing on reforestation, waste management, and energy efficiency rather than participation in verified carbon credit markets. While policy support and environmental awareness serve as key enablers, adoption remains limited by weak verification standards, insufficient technical capacity, high costs, and low consumer trust. The study concludes that a multi-level governance framework integrating transparent MRV systems, institutional strengthening, and stakeholder collaboration is essential to transform tourism's potential into measurable contributions to Indonesia's decarbonization agenda.*

***Keywords****: Carbon Offsetting, Decarbonization, Hospitality Industry, Net Zero Emission, Systematic Literature Review, Sustainable Tourism Sector.*

***ABSTRAK***

*Industri pariwisata merupakan salah satu kontributor utama emisi gas rumah kaca global, sehingga penyeimbangan karbon menjadi jalur penting dalam mendorong transisi menuju keberlanjutan. Penelitian ini bertujuan untuk memetakan dan mensintesis literatur ilmiah mengenai praktik penyeimbangan karbon dalam sektor perhotelan dan pariwisata di Indonesia, menelaah bagaimana konfigurasi partisipasi sektor dalam penyeimbangan karbon, serta menganalisis faktor-faktor regulasi, ekonomi, operasional, dan pasar yang memungkinkan maupun menghambat adopsi dan perluasan praktik tersebut, sejalan dengan target nasional emisi nol bersih tahun 2060. Penelitian ini menggunakan metode systematic literature review yang dipandu oleh protokol PRISMA 2020, dengan menganalisis 30 artikel peer-reviewed yang diterbitkan antara tahun 2020 hingga 2025 untuk menjamin ketelitian metodologis dan replikabilitas. Hasil kajian menunjukkan bahwa praktik penyeimbangan karbon dalam sektor pariwisata di Indonesia masih*

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*bersifat tidak langsung dan sukarela, dengan fokus utama pada kegiatan reforestasi, pengelolaan limbah, dan efisiensi energi, serta belum banyak melibatkan partisipasi dalam pasar kredit karbon yang terverifikasi. Meskipun dukungan kebijakan dan peningkatan kesadaran lingkungan berperan sebagai faktor pendorong utama, tingkat adopsi masih dibatasi oleh lemahnya standar verifikasi, keterbatasan kapasitas teknis, tingginya biaya, dan rendahnya tingkat kepercayaan konsumen. Penelitian ini menyimpulkan bahwa kerangka tata kelola multilevel yang mengintegrasikan sistem pengukuran, pelaporan, dan verifikasi yang transparan, penguatan kelembagaan, serta kolaborasi antarpemangku kepentingan diperlukan untuk mentransformasikan potensi sektor pariwisata menjadi kontribusi yang terukur terhadap agenda dekarbonisasi Indonesia.*

***Kata kunci**: Pengimbangan Karbon, Dekarbonisasi, Industri Perhotelan, Emisi Nol Bersih, Tinjauan Pustaka Sistematis, Sektor Pariwisata Keberlanjutan.*

## INTRODUCTION

Climate change has been widely recognized as the most pressing global environmental issue of the 21st century, posing significant threats to ecosystems, human welfare, and the stability of global economies (Mudau et al., 2022). The tourism sector, heavily reliant on transport, accommodation, and energy-intensive activities, has emerged as one of the major contributors to Greenhouse Gas (GHG) emissions, thereby exacerbating global climate challenges (Zovko & Zovko, 2024). International efforts toward decarbonization have increasingly emphasized the role of tourism in mitigating its environmental footprint through energy-efficient technologies, stricter emission regulations, and the promotion of sustainable consumption and production patterns. Within this global framework, tourism's interconnection with climate change has become both a vulnerability and an opportunity for transition toward low-carbon operations.

The tourism industry contributes about 8% of global GHG emissions, including from transportation, accommodation, and services (Dolnicar & Greene, 2025; Filali et al., 2025). From 2009–2019, emissions grew 3.5% annually to 5.2 Gt-e, doubling the global economy's rate, driven by rising travel demand and slow energy efficiency gains (Sun et al., 2024). Air travel accounts for 20% of tourism's footprint, hotels and restaurants 5% of global emissions (Adeniran et al., 2024). High-income countries dominate emissions due to unequal travel patterns (Lenzen et al., 2018). Unmitigated, post-pandemic emissions may rise 3% yearly, demanding decarbonization (Debbage & Debbage, 2019).

In response to environmental concerns, carbon offsetting has emerged as a complementary strategy to direct emission reduction, allowing organizations and individuals to compensate for emissions through projects like reforestation or renewable energy (Amicarelli et al., 2021). Adoption in the tourism sector remains uneven: airlines have pioneered schemes such as Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), yet passenger participation is limited and corporate commitments fluctuate with regulatory and cost pressures (Zhang et al., 2021). Hotels show growing interest in sustainability certifications and reporting, but formal offset programs are fragmented and inconsistently monitored. Despite market growth, credibility and permanence of offset credits remain concerns, highlighting the need for stronger governance and transparency mechanisms (Fujii et al., 2024; Calel et al., 2025)

Indonesia's government commits to Net Zero Emissions (NZE) by 2060 and up to 41% emission reduction by 2030 with international aid (Arifin et al., 2023). This is formalized via Presidential Regulation Number 98 of 2021 on Economic Value of Carbon and the Indonesia Carbon Exchange (IDX Carbon), establishing regional carbon governance leadership (Wardana et al., 2022; Loudoe & Sakti, 2024). Policies promote carbon pricing, trading, low-carbon investments, and private sector involvement. Tourism offers potential for offsetting through environmental ties and visitor-linked reductions, exemplified by mangrove planting and low-carbon village programs (Susilorini et al., 2022; Septiana et al., 2024). Yet, hospitality and tourism engagement is limited by high

costs, inadequate regulations, technical gaps, and consumer skepticism (Adeniran et al., 2024; Shereni & Rogerson, 2024).

Despite Indonesia's supportive regulatory environment and abundant natural assets for nature-based solutions, the country's hospitality and tourism sector has yet to capitalize fully on carbon offsetting as part of its sustainability strategy. The research gap lies in the absence of a comprehensive synthesis examining how this sector engages with carbon offsetting programs its drivers, barriers, and integration within national climate policies. Studies by Purnamasari and Nurachmah (2023), Scott (2024), and Calel et al. (2025) have primarily focused on carbon markets or energy transition, with little systematic attention to tourism's role.

This study aims to comprehensively map the scholarly landscape on carbon offsetting in Indonesia's hospitality and tourism sector by first identifying the dominant research themes and thematic categorizations within the existing literature, as well as the prevailing forms, trends, and patterns of academic publication. The study examines the extent and configuration of hospitality and tourism sector participation in carbon offsetting in Indonesia, including the roles of key actors, the types of offsetting instruments employed, the nature of offset projects, and the verification practices applied. This study also analyzes the regulatory, economic, operational, and market-related factors that enable or hinder the adoption and scaling of carbon offsetting across the sector, and elucidates the mechanisms through which these factors influence sectoral engagement. The study offers four interrelated contributions: a geographically specific synthesis, integration of hospitality and environmental perspectives, a rigorous PRISMA approach, and practice-ready insights for policymakers and industry actors.

## LITERATURE REVIEW

### Conceptual Foundations of Carbon Offsetting in Tourism

The concept of carbon offsetting in sustainable tourism has developed alongside increasing awareness of travel-related environmental impacts, particularly from transport and accommodation. Grounded in sustainable tourism development and environmental economics theory, this approach emphasizes balancing economic growth, environmental protection, and community welfare through responsible resource management (Khan et al., 2020; Baloch et al., 2022). Sustainable tourism development focuses on waste reduction, biodiversity conservation, and integrated environmental–economic policies, while environmental economics theory promotes internalizing externalities through mechanisms such as carbon taxes and emission trading to encourage responsible behavior in tourism (Li et al., 2024; Raihan, 2024a; Amani & Mangruwa, 2025).

Formally established under the Kyoto Protocol (1997), carbon offsetting allows emission reductions through the purchase of carbon credits in regulated markets (Zhu & Wang, 2023). In tourism, it has evolved from tree-planting projects to strategic carbon neutrality initiatives across destinations (Xia, 2024). This framework now involves governments, businesses, and tourists collaborating through incentives and regulations to achieve net-zero goals. Carbon neutrality is realized by balancing emitted and absorbed carbon via emission trading, carbon taxation, and Voluntary Carbon Markets (VCMs), where firms and travelers purchase verified credits (Zhu & Wang, 2023; Li et al., 2024). Governments provide regulatory clarity and incentives to ensure participation and transparency (Song et al., 2024). Despite challenges related to responsibility, policy consistency, and monitoring, the integration of environmental-economic logic and sustainable development continues to foster innovation and low-carbon tourism pathways (Khan et al., 2020).

### Stakeholder Participation and Roles in Tourism Carbon Offsetting

Stakeholder participation represents the cornerstone of effective tourism carbon-offsetting initiatives, as collaboration and legitimacy determine both the success and sustainability of offset programs. Guided by Stakeholder Theory and Collaborative Governance Theory, participation in carbon offsetting is conceptualized as a shared

process involving governments, tourism enterprises, local communities, and tourists, each contributing distinct roles, motivations, and capacities (Wondirad et al., 2020; Zhou et al., 2023).

From a Stakeholder Theory perspective, successful offset governance requires acknowledging and accommodating the interests of diverse actors according to their power, legitimacy, and urgency. Governments primarily act as regulators and facilitators, designing policies, providing incentives or sanctions, and ensuring inter-sectoral collaboration to promote carbon-neutral tourism (Li et al., 2024). The tourism industry, as a principal executor, integrates low-carbon innovations into its operations by developing eco-friendly products, investing in verified offset projects, and strengthening collaboration with state and community actors (Song et al., 2024). However, corporate participation is often shaped by short-term profit orientation and sensitivity to regulatory pressures.

Local communities function as beneficiaries, monitors, and implementers of community-based offset initiatives such as reforestation, mangrove rehabilitation, or eco-tourism ventures. Their involvement reinforces the social legitimacy of offset projects but often remains constrained by limited empowerment and institutional capacity (Bichler & Lösch, 2019; Wondirad et al., 2020). Meanwhile, tourists operate as consumers, financial supporters, and behavioral change agents, participating through voluntary carbon payments or the selection of low-carbon travel products. Their decisions are highly dependent on perceived value, accessibility, and transparency regarding offset benefits (Song et al., 2024).

**Collaborative Governance in Carbon Offsetting**

The Collaborative Governance Theory deepens this understanding by emphasizing inclusive dialogue, trust-building, and joint leadership. Effective offset governance emerges when power asymmetries are mitigated through transparent and accountable decision-making structures, where "small wins" and visible outcomes reinforce trust and long-term engagement among participants (Bichler & Lösch, 2019; Zhou et al., 2023). Such collaboration transforms offset projects from fragmented environmental interventions into institutionalized sustainability mechanisms aligned with climate-policy objectives.

The adoption of carbon-offsetting practices is further influenced by enablers and barriers identified through Diffusion of Innovation Theory and Protection Motivation Theory. Policy incentives, regulatory clarity, and technological innovation serve as key enablers of adoption, whereas high initial costs, limited technical capacity, and regulatory complexity act as critical barriers (Elmo et al., 2020; Li et al., 2024). On the behavioral side, environmental awareness, perceived climate risks, and ecological values enhance willingness to participate, while skepticism toward offset credibility, low knowledge, and trust deficits inhibit engagement (Song et al., 2024; Zhang et al., 2025). Stakeholder participation in tourism carbon offsetting reflects a dynamic interaction between governance structures, institutional incentives, and behavioral motivations. The convergence of stakeholder, collaborative governance, diffusion of innovation, and protection motivation frameworks underscores that carbon offsetting in tourism can only achieve legitimacy and scalability through integrated, trust-based, and innovation-driven multi-actor collaboration.

## RESEARCH METHODS

This study employs a Systematic Literature Review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure rigor, transparency, and replicability. The study ensures validity through clear PICOC criteria, selection of peer-reviewed databases, and focus on relevant literature from 2020–2025, reliability is maintained via a layered screening process and systematic data checks, while transparency is achieved through documented search strings, PRISMA diagrams, and inclusion/exclusion tables. It synthesizes evidence on Indonesia's

hospitality and tourism sector's involvement in carbon offsetting, emphasizing participation extent, instruments, and adoption factors, while aligning with national decarbonization goals. A structured search was conducted across Scopus, Taylor & Francis, SAGE Journals, and ScienceDirect, selected for their coverage in sustainability, environmental management, and tourism. Using Boolean operators, the search string was: ("carbon offset" OR "carbon credit" OR "carbon compensation" OR "carbon neutrality" OR "carbon trading") AND ("tourism" OR "hospitality" OR "hotel" OR "travel industry" OR "destination management") AND ("sustainability" OR "environmental management" OR "ESG" OR "green tourism"). This yielded 2,684 records: Scopus (n=59), Taylor & Francis (n=745), SAGE Journals (n=313), and ScienceDirect (n=1,567).

Inclusion and exclusion criteria were defined via the PICOC framework (Population, Intervention, Comparison, Outcome, Context) to focus on carbon offsetting in hospitality and tourism, especially in Indonesia or similar developing contexts. The PRISMA screening involved four stages: removing 1,942 duplicates left 742 unique articles; title and abstract screening excluded 571 for irrelevance or lack of empirical value; 171 full-text articles were assessed, excluding 140 for wrong type (n=48), irrelevant focus (n=67), or non-English (n=25). The final 30 studies were qualitatively analyzed to address: participation extent and configuration, and enabling/constraining factors for adoption and scaling. This process maps evidence transparently, reflecting Indonesia's path to low-carbon tourism and Net Zero Emission (NZE) 2060.

This review applies the PICOC framework to structure the analysis. The population covers tourism and hospitality stakeholders, hotels, resorts, tour operators, destinations, and local communities involved in carbon offsetting. The intervention includes mechanisms such as carbon credits, reforestation, renewable energy, and carbon accounting. The comparison contrasts participating and non-participating entities or different offset types. The outcome identifies participation patterns, enablers, barriers, and relevance to Indonesia's NZE 2060 goal. The context focuses on Indonesia and Asia-Pacific studies published between 2015-2025 in sustainability and tourism journals. The sequential identification, screening, and eligibility procedures that operationalize these criteria are visually summarized in Figure 1.

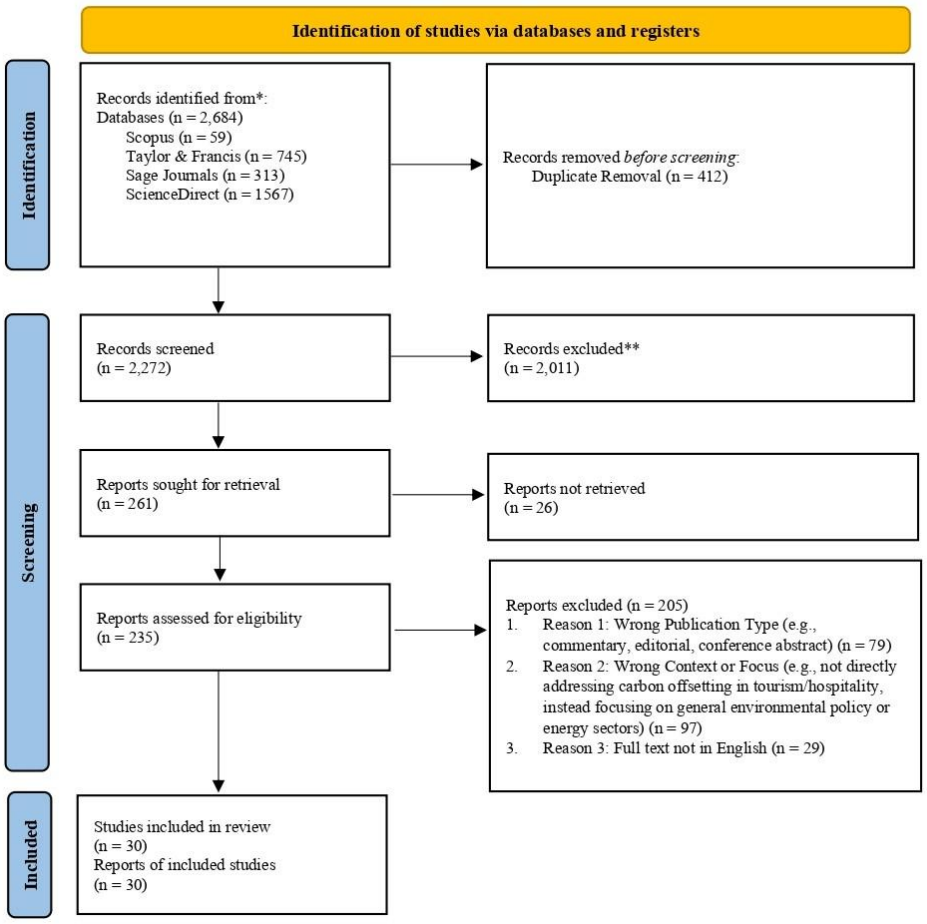


**Figure 1.** PRISMA 2020 Flow Diagram for Study Selection

Based on Figure 1, from 2,684 records, 412 duplicates were removed pre-screening. Of 2,272 records, 2,011 were excluded via title/abstract for irrelevance. Full-text retrieval sought 261 reports (26 inaccessible); 235 were assessed, excluding 204 for inappropriate type (n=78), irrelevant focus (n=97), or non-English (n=29). This yielded 30 studies for analysis on carbon offsetting in Indonesia's hospitality and tourism.

The study applied clear inclusion and exclusion criteria to ensure relevance and quality. Only peer-reviewed journal articles published between 2020 and 2025 in English were included, focusing on carbon offsetting, carbon credits, or emission-reduction initiatives in the tourism and hospitality sectors, especially within Indonesia or comparable developing countries. Eligible studies encompassed empirical, qualitative, quantitative, mixed-method, or review research. Excluded materials included preprints, editorials, conference abstracts, policy briefs, book chapters, and studies unrelated to carbon offsetting in tourism.

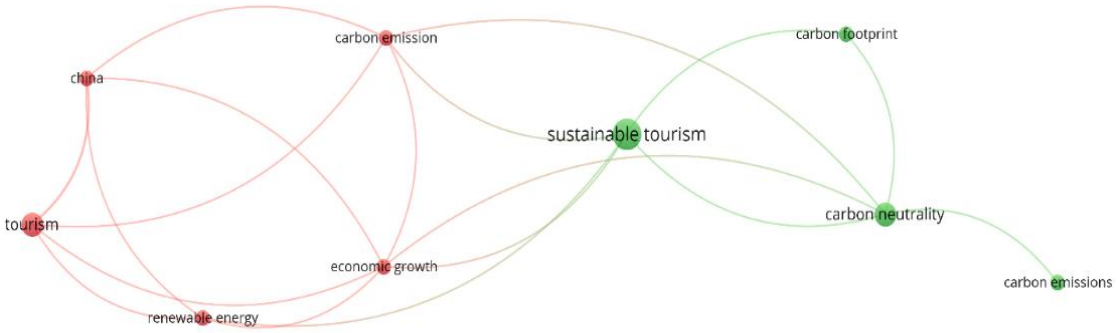


**Figure 2.** Network Visualization of Co-occurring Keywords from the Included Studies

Based on Figure 2, two clusters emerge: one (red) on tourism, carbon emissions, renewable energy, and economic growth, emphasizing macro-sustainability; the other (green) on sustainable tourism, carbon neutrality, and footprint, focusing on low-carbon strategies. Linkages highlight convergence in environmental and tourism agendas for carbon offsetting research.

## RESULTS

### Thematic Categorization of Reviewed Studies

To preserve analytical depth while minimizing page length, the descriptive per-study characteristics table was replaced with a thematic synthesis that clusters the included studies by their primary analytical contribution to the research questions: extent and configuration of participation; and enablers, barriers, and mechanisms of adoption. This approach is consistent with best practice in systematic reviews when the corpus is heterogeneous in aims and methods: rather than repeating near-duplicate metadata across dozens of rows, the synthesis emphasizes convergent patterns of evidence, methodological families, and the governance or market mechanisms that recur across contexts barriers (Li et al., 2024). The resulting clusters differentiate between system-level modeling and macro evidence; behavioral and consumer-side adoption; corporate, event, and supply-chain carbon management; hospitality operations among SMEs in Global South settings; community- or destination-level initiatives; and governance, discourse, and strategic pathways. This structure directly maps to the research questions and allows a tighter integration of findings with policy and managerial implications. The 30 studies were organized into six thematic clusters, each defined by a shared scope and dominant methods, a characteristic configuration of participation, and a recurrent set of enabling and constraining conditions. Table 1 presents the clusters, their rationales, typical methodological toolkits, participation types, and the specific study numbers included in each theme.

**Table 1.** Thematic Categorization of Reviewed Studies

| Cluster / Theme | Scope & Rationale | Typical Methodologies | Participation Type (RQ1) | Key Enablers/ Barriers (RQ2) | Included Studies |
|---|---|---|---|---|---|
| Macro-Modeling & System-Level Analyses | Systemic and long-run analyses of tourism–carbon dynamics and neutrality pathways; develops indices, spatial couplings, and predictive assessments informing policy design. | Evolutionary games; econometrics (ARDL, cointegration); DEA/eco-efficiency; spatial coupling and remote sensing; AI/ML assessments. | Mostly indirect participation: modeling of drivers/pressures rather than verified offset practice. | Enablers: policy incentives, renewable-energy expansion, technological innovation, high-quality data. Barriers: fossil dependence, regional imbalance, data/verification gaps. | Chikezie et al. (2022), Li et al., (2022), Yu, (2023), Zhang et al., (2024), Li et al. (2024) Raihan, (2024a), Xia (2024), Raihan, (2024b) and |

| Cluster / Theme | Scope & Rationale | Typical Methodologies | Participation Type (RQ1) | Key Enablers/ Barriers (RQ2) | Included Studies |
|---|---|---|---|---|---|
| | | | | | Zhang (2024) |
| Behavioral & Consumer Adoption of Offsets | Explains travellers'/guests' willingness to adopt VCOs and hotel/experience-linked offsets; tests message framing, risk, efficacy, and trust pathways. | Experiments; survey-based SEM/PLS-SEM; psychological models (TPB, EPPM). | Individuals opt-in via airline/hotel (VCOs) or have an intention toward offset-linked experiences. | Enablers: credible messaging, knowledge, perceived efficacy, service quality. Barriers: affordability concerns, scepticism/greenwashing, risk salience without efficacy. | Denton et al. (2020), Liu et al. (2023), Fabiana Peixoto de and Macario (2024), Wang et al. (2024) and Khan et al. (2025) |
| Corporate, Event & Supply-Chain Carbon Management | Firm- and system-level footprinting (airlines, events, inbound tourism) and vendor/market perspectives; pathways for integrating residual offsets after reduction. | LCA (event/stadium); national inbound footprinting; corporate practice audits; offset-vendor interviews. | Firm-mediated participation (footprint disclosure, $CO_2$ calculators, residual offset packaging). | Enablers: standards/guidelines, third-party verification, digital tools, policy signals. Barriers: Scope-3 dominance, complex data collection, cost, and customer confusion. | Dodds et al. (2012), Kitamura et al. (2020), Amicarelli et al. (2021), Al Sholi et al. (2023), and Popović et al. (2025) |
| Hospitality Operations & SME Mitigation (Global South) | Operational decarbonization among SMEs in hospitality (energy efficiency, recycling, green certifications) as precursors to formal offsets. | Cross-sectional surveys; descriptive/ANOVA analytics. | Indirect/early-stage participation; limited guest fees or tree-planting without verified MRV. | Enablers: cost savings, regulation, staff engagement, CSR/image. Barriers: financial/technical constraints, policy gaps, weak measurement/price signals. | Shereni (2024) and Shereni and Rogerson (2024) |
| Community-/Nature-Based & Destination-Level Initiatives | Place-based tourism decarbonization and conservation finance (mangroves, forests, renewables, EV mobility; parks/destinations). | Field inventories & valuation; choice experiments (WTP); mixed-methods case studies. | Community/destination-level participation; measurable carbon services and visitor funding; limited registry-linked credits. | Enablers: legal tenure, co-benefits, local engagement, tourist support. Barriers: MRV and registry linkage gaps, infrastructure/skills/finance deficits. | Nhamo et al. (2023), Suhardono et al. (2024), Koko et al. (2025), and Oktriono et al. (2025) |
| Governance, Discourse, & Strategic Pathways | Media/ESG discourse shaping agendas and syntheses outlining multi-level governance for carbon-neutral tourism. | Text mining/topic modeling; qualitative/thematic reviews. | Indirect participation via agenda-setting and governance frameworks. | Enablers: policy momentum, transparent communication, coordinated governance. Barriers: misinformation, coordination failures, and low credibility of offsets. | Kang et al. (2023) and Hatamifar et al. (2025) |

Based on Table 1, the literature groups tourism carbon-offset research into three main clusters. The macro-modeling and system-level analyses cluster examines national or regional tourism carbon dynamics using econometric and input-output models to project decarbonization pathways and assess eco-efficiency. The behavioral and consumer-side adoption cluster explores tourists' willingness to pay, psychological motivations, and communication strategies for voluntary offsets, with hospitality firms mediating participation. The corporate, event, and supply-chain carbon management cluster focuses on firm-level practices such as carbon accounting and life-cycle assessments, integrating offsets through reforestation, renewable projects, and low-carbon operations.

**Publication Trends and Scholarly Landscape**

The temporal distribution of the 30 included studies demonstrates a marked increase in scholarly attention to carbon offsetting and decarbonization in the hospitality and tourism sectors between 2020-2025. In 2020, four studies laid foundational work on behavioral drivers of offset adoption and carbon footprint evaluation in events and aviation, reflecting early pandemic-era reflections on sustainable recovery. By 2021, three publications expanded into corporate commitments and Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) baseline adjustments, signaling a shift toward regulatory and market mechanisms. The year 2022 saw five studies, emphasizing environmental sustainability linkages with economic growth, tourism village footprints, and stakeholder collaboration, indicating growing integration of offsetting into broader ESG agendas (Khan et al., 2020; Baloch et al., 2022).

Publication volume peaked in 2023 with six studies, covering topics from collaborative governance and media discourse on ocean economy sustainability to carbon-neutral game analysis and event-based circular economy practices. This surge aligns with global post-pandemic recovery efforts and heightened focus on net-zero pathways. In 2024, seven articles addressed diverse themes, including priority shifts in voluntary markets, spatial carbon neutrality patterns, and renewable energy's role in tourism sustainability, underscoring accelerated research on practical implementation. Finally, 2025 contributed five studies on visitor willingness to pay, carbon pressure indices, and adaptive strategies in forestry heritage sites, highlighting maturing discourse on measurable, site-specific interventions.

Geographically, the studies span global, regional, and national contexts, with a notable emphasis on Asia (particularly China, Indonesia, and Japan) and emerging economies (Elmo et al., 2020). Eleven studies focus on Asia-Pacific settings, including Indonesia-specific cases on mangrove restoration, waste management in tourism villages, and decarbonization in islands like Nusa Penida. European and African perspectives appear in six studies, often through comparative or theoretical lenses, while global or multi-country analyses dominate the remaining 13, providing transferable insights for Indonesia. Disciplinarily, the corpus draws from environmental science (12 studies), tourism management (10), sustainability studies (5), and economics/policy (3), fostering interdisciplinary convergence on carbon offsetting, sustainability, and ESG frameworks in the post-pandemic recovery era. The upward trajectory suggests that carbon offsetting has transitioned from a peripheral discussion to a central focus of tourism sustainability research, driven by expanding global commitments to decarbonization and the operationalization of carbon trading mechanisms in developing economies such as Indonesia.

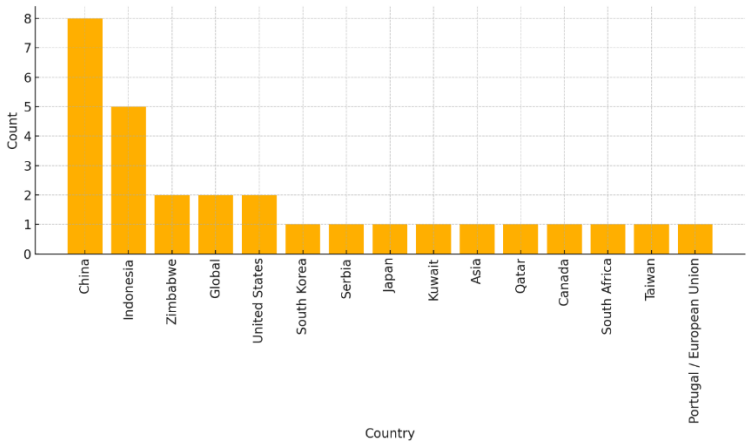


**Figure 3.** Publications by Country

Based on Figure 3, the geographical distribution of the included studies shows a significant concentration in China (n=8), followed by Indonesia (n=5), with the remaining studies dispersed across countries such as Zimbabwe, the United States, South Korea, Japan, and others. This pattern indicates that research on tourism-related carbon offsetting is still regionally concentrated in Asia, particularly in emerging economies actively pursuing sustainability transitions. Indonesia's growing representation reflects rising national attention to integrating carbon management within the tourism sector, aligning with its Net Zero Emission (NZE) 2060 commitment.

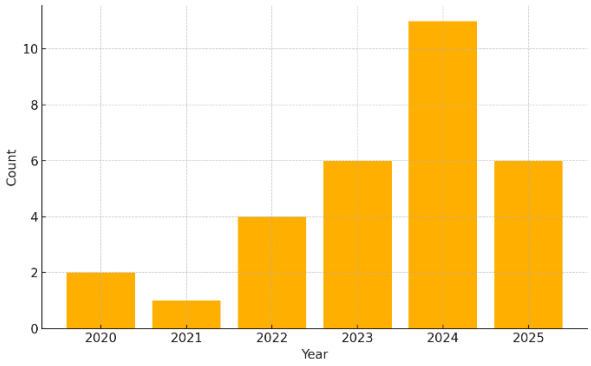


**Figure 4.** Publication by Year

Based on Figure 4, the temporal trend reveals a marked increase in scholarly output between 2020 and 2025, peaking in 2024 with eleven publications. This sharp rise demonstrates growing academic and policy engagement with carbon offsetting, sustainability, and ESG frameworks in the post-pandemic recovery era. The upward trajectory suggests that carbon offsetting has transitioned from a peripheral discussion to a central focus of tourism sustainability research, driven by expanding global commitments to decarbonization and the operationalization of carbon trading mechanisms in developing economies such as Indonesia.

**Configuration of Hospitality and Tourism Participation in Carbon Offsetting**

The systematic synthesis of 30 selected studies reveals that the extent and configuration of carbon offsetting participation across the hospitality and tourism sectors remain fragmented, unevenly distributed, and predominantly characterized by early-stage or indirect involvement. While global frameworks and supportive policy architecture offer institutional foundations, actual sectoral engagement remains nascent and largely exploratory. Most empirical evidence identifies tourism enterprises, hotels, destination managers, and local communities as potential actors rather than established participants

in verified offset markets (Zhou et al., 2023). These actors operate primarily through voluntary, small-scale, or project-based initiatives such as mangrove reforestation, ecotourism-linked restoration programs, or community-based conservation efforts without integration into certified mechanisms (Hadiningsih & Eddyono, 2025).

Across methodologies, several studies articulate a firm-mediated participation model in which hotels, tour operators, or event organizers facilitate consumer offset purchases or bundle offset options into travel products. Tourists' willingness to purchase carbon offsets is mediated by hospitality firms through partnerships with nonprofit providers and localized tree-planting projects reflecting a consumer-facing configuration where firms act as intermediaries rather than as direct project developers (Wondirad et al., 2020). Offset integration is conceptualized as an add-on to emissions disclosure and product labeling, whereby accommodation providers and destinations offer optional offsetting to guests. However, neither report verified offset transactions or adherence to registry-based monitoring, verification, and reporting standards, underscoring the largely voluntary and unstandardized nature of current participation practices.

At the macro level, participation often manifests indirectly through carbon accounting, emission measurement, or life-cycle assessment approaches that prepare the ground for future offset integration. The measurement and disclosure of event-related and inbound tourism footprints are prerequisites for credible offsetting, while indices such as the Tourism Carbon Pressure Index and eco-efficiency metrics delineate emission hotspots and absorption capacities (Zhang et al., 2021). These position offsetting as a complementary measure to be layered atop energy-efficiency and renewable-energy interventions rather than as a mainstream mitigation instrument. This analytical pattern underscores that, while the conceptual space for carbon offsetting within tourism is expanding, its operational footprint remains marginal compared to broader decarbonization practices like energy transition and green transport initiatives.

In Indonesia, tourism-related carbon offset initiatives remain largely informal and community-based, focusing on localized projects such as carbon stock measurement in Mount Bromo and circular-economy tourism in Sukunan Village. While these activities demonstrate emission reduction and community engagement, they lack registry verification and integration with formal carbon markets. Participation extends to sectors like aviation and MICE, where voluntary offset programs and event-based carbon management show potential models for Indonesia's emerging carbon framework (Bichler & Lösch, 2019. However, third-party-certified offsets remain rare due to limited technical expertise, weak regulatory guidance, and the absence of standardized monitoring. Nature-based solutions, especially blue carbon and mangrove restoration, offer strong opportunities but require institutional coordination across tourism, environmental, and financial authorities. Indonesia's tourism carbon offsetting remains fragmented and transitional, characterized by multi-actor participation but hindered by institutional, technical, and regulatory gaps that must be addressed for verified, transparent implementation (Adeniran et al., 2024; Shereni & Rogerson, 2024).

**Factors Influencing the Adoption and Scaling of Carbon Offsetting**

Drawing upon 30 peer-reviewed studies, the adoption and scaling of carbon offsetting in the hospitality and tourism sectors are influenced by policy frameworks, organizational capacity, behavioral factors, financial constraints, and institutional readiness. While policy instruments and rising environmental awareness create enabling conditions, systemic barriers such as weak verification, limited technical capacity, and credibility gaps continue to hinder widespread implementation. At the policy level, coherent incentives, enforcement, and verification structures promote participation, whereas weak governance and inconsistent subsidies reduce engagement (Kang et al., 2023; Li et al., 2024).

Organizational disparities shape adoption patterns. Airlines and multinational tourism firms lead voluntary carbon offset programs, sustainable aviation fuel initiatives, and carbon disclosure systems, while small and medium-sized hospitality enterprises, especially in emerging economies, are often confined to energy efficiency and waste

reduction due to limited financial and technical capacity (Shereni, 2024; Shereni & Rogerson, 2024). Similarly, event organizers face data fragmentation and Scope 3 accounting challenges that prevent comprehensive offset implementation (Kitamura et al., 2020).

Behavioral and psychological factors play a key role in uptake. Trust, transparency, perceived efficacy, and affordability critically influence consumer participation, while third-party verification and recognized certification standards (e.g., VCS, Gold Standard) mitigate skepticism and greenwashing concerns (Mello & Macario, 2024). Local Indonesian case studies such as Bromo SPFA and Nusa Penida demonstrate measurable carbon reduction potential, yet lack MRV systems and registry linkage, limiting formal market participation (Suryawan et al., 2025; Oktriono et al., 2025).

At the macro-structural level, renewable energy expansion, international cooperation, and robust environmental regulation serve as enablers, while fossil-fuel dependence, industrial pressures, and weak institutional coordination hinder scaling (Ekwueme et al., 2023; Zhang et al., 2024). Effective scaling of carbon offsetting hinges on a dual foundation: MRV-compliant, registry-linked carbon projects, and verified, transparent communication to enhance behavioral confidence. Policymakers should prioritize standardization, cross-sectoral coordination, and capacity building, while firms should embed certified, consumer-facing offset mechanisms to ensure legitimacy and contribute meaningfully to Indonesia's Net Zero Emission 2060 goal (Li et al., 2024).

## DISCUSSION

The findings of this systematic review highlight the fragmented and exploratory nature of carbon offsetting participation in Indonesia's hospitality and tourism sectors, primarily manifesting through indirect emission reductions rather than verified mechanisms. This aligns with Shereni and Rogerson (2024), who observed similar patterns in the Global South, where hospitality operations focus on basic sustainability practices like energy efficiency due to resource constraints, contrasting with more advanced, certified offset integrations in developed economies, as noted by Amicarelli et al. (2021) in aviation. Unlike earlier studies emphasizing global tourism's 8% GHG contribution and projected 3% annual post-pandemic rise, the current review reveals Indonesia's transitional phase, where localized projects like mangrove restoration lack market linkages, differing from mature systems in Europe that incorporate robust MRV (Zhang et al., 2021; Calel et al., 2025). According to Arifin et al. (2023), Indonesia's policy framework, such as Presidential Regulation Number 98 of 2021, provides a foundation, but implementation lags behind international benchmarks like CORSIA, underscoring a gap between ambition and execution compared to pre-2020 research on voluntary schemes.

Firm-mediated participation models, where hotels and operators bundle offsets into consumer products, resonate with Denton et al. (2020), who demonstrated that intermediaries enhance tourist willingness via nonprofit partnerships and tree-planting, yet the review's emphasis on unstandardized practices in Indonesia diverges from Liu et al. (2023)'s experiments showing higher adoption with transparent framing. This is in line with Mello and Macario (2024), who argued that trust and clarity boost voluntary carbon offsetting in aviation, but the current findings highlight persistent scepticism in hospitality, extending Dodds et al. (2012)'s concerns over greenwashing in Canada and the US to emerging markets like Indonesia. Compared to Kitamura et al. (2020)'s event-sector carbon accounting in Japan, which prepares for offsets through Scope 3 measurements, Indonesian cases like Sukunan Village's waste models remain preparatory and informal, lacking the technical sophistication seen in prior Asian studies, thus illustrating a developmental disparity (Susilorini et al., 2022; Suryawan et al., 2025; Oktriono et al., 2025).

Barriers such as high costs, technical deficits, and inadequate regulations in Indonesia mirror Adeniran et al. (2024)'s analysis of African hospitality, where similar hurdles limit decarbonization, but enablers like renewable energy willingness in Nusa Penida build on Kang et al. (2023)'s media discourse on ocean sustainability, suggesting potential for

growth absent in earlier fossil-dependent contexts (Suhardono et al., 2024; Fujii et al., 2024). This review's identification of verification gaps in projects like Bromo's carbon stocks contrasts with Septiana et al. (2024)'s sustainable geotourism in Raja Ampat, which integrates community benefits more effectively than pre-pandemic village models, indicating evolving but uneven progress. According to Li et al. (2024), balanced incentives foster cooperation, yet the findings argue that Indonesia's weak enforcement generates inefficiencies, differing from Wardana et al. (2022)'s optimistic view of carbon tax learning.

In the Indonesian context, nature-based solutions hold promise but require registry integration, as seen in Loudoe and Sakti (2024)'s investment management role, extending Purnamasari and Nurachmah (2023)'s fair carbon market implementation to tourism. This aligns with Scott (2024)'s call for tourism-climate crisis alignment, but the review's multi-actor fragmentation highlights a slower pace than global net-zero pathways. The implications underscore the need for policymakers to enhance MRV systems and incentives, firms to adopt certified offsets for credibility, and educators to build consumer trust, ultimately positioning the sector as a key contributor to NZE 2060 (Debbage & Debbage, 2019; Sun et al., 2024).

## CONCLUSION

This systematic review of 30 peer-reviewed studies found that carbon offsetting in Indonesia's hospitality and tourism sectors remains fragmented and transitional, with most efforts emphasizing emission reduction, such as energy efficiency, waste management, and reforestation, rather than certified offsetting. Verified mechanisms like MRV-linked carbon credits are still rare. While national policies such as Presidential Regulation Number 98 of 2021 and the IDX Carbon Exchange provide an enabling foundation, sector-specific regulations, financial incentives, and verification systems are still underdeveloped.

Practical and theoretical implications highlight that scaling offset initiatives requires alignment among policy design, business innovation, and consumer engagement. Institutional credibility, economic feasibility, and behavioral trust emerge as key determinants. The findings reinforce multi-level governance and stakeholder collaboration as critical frameworks for integrating sustainability and market mechanisms in tourism carbon management. Research limitations include the narrow temporal range (2020–2025) and the limited number of Indonesia-focused empirical studies, restricting generalizability and longitudinal insights.

Future research should adopt mixed-method and longitudinal approaches to examine verified carbon accounting, consumer behavior toward certified offsets, and policy industry interaction. Expanding comparative studies across ASEAN and developing standardized measurement, reporting, and verification frameworks will help strengthen the scientific, institutional, and market foundations of Indonesia's pathway toward Net Zero Emission (NZE) 2060.

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