Tourism Value Chain Analytics
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Reconstructing the Tourism Value Chain Under Carbon Neutrality: From Resource Consumption to Circular Economy

Abstract

This research explores the rebuilding of tourism value chains in the context of carbon neutrality, emphasising the shift from linear, resource-dependent models to circular economy systems. Through carbon hotspot analysis, intervention assessment, case studies, stakeholder analysis, and employing a mixed-methods approach, we seek to understand how emission reduction aligned with circular principles can occur in various segments of tourism while sustaining economic and experiential value for visitors. Our results show that the transportation and accommodation sectors offer the highest carbon reduction potential of 65 and 40 tCO2e/year/1000 tourists, respectively, through narrowing resource flow interventions. The effectiveness of circular interventions varies by segment; however, coordinated cross-segment implementation results in 50-70% carbon reduction compared to 15-30% from segment-specific approaches. This research identifies three primary circular strategies—narrowing, slowing, and closing resource flows—with tailored applications across the entire tourism value chain. Circular transitions are made possible by the optimisation and restructuring of business models, which are enabled primarily by digital technologies. This study provides a focal framework for stakeholders to strategically and systematically identify opportunity gaps for interventions, prioritise actions, carve governance frameworks to shape incentives towards interventions that scaffold carbon neutrality targets, thus demonstrating the feasibility of circular approaches in achieving carbon neutrality while enhancing economic outcomes.

Key words:circular economy; tourism value chain; carbon neutrality; sustainable tourism; resource optimization

1 Introduction

As one of the most important industries on a global scale, tourism is under intense pressure to contain its carbon footprint while dealing with climate change concerns. Tourism activities contribute significantly to international greenhouse gas emissions via transportation, accommodation, food services, and various recreations. The entire industry now faces a make-or-break moment wherein radical changes to the value chain as a result of carbon neutrality commitments by various nations are mandatory. This, in turn, requires a move from traditional carbon intensive operations towards circular economy principles which focus on waste and resource use minimisation, as well as overall carbon emissions reduction.

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Given the redesign of the tourism value chain, its system processes, operations, and activities, the circular economy framework can reshape tourism circularity focusing on resources inflow and outflow as classified by [1] and enhance sustainability. Unlike the typical linear tourism development "take–make–dispose" model, circular approaches figure out how one resource can be used as an input for another by closing the loop of resource use, prolonging the lifespan of the products, and restoring natural systems. Based on more recent works, implementing circular principles can dramatically lessen the negative environmental effects while further harnessing tourism enhancement opportunities and other services [5]. In tourism, these concepts can be integrated into the accommodation facilities, transportation systems, food services, and attractions management to enhance carbon reduction while servicing the clientele.

The complexities in addressing the issue of tourism's carbon footprint are exacerbated by its regional variations. A case in point, studying tourism in Spain brought to light the significant reductions in carbon emissions during the COVID-19 pandemic which provided important lessons on how tourism emissions could be decarbonised in the recovery phase. Emerging tourism hotspots like Hainan Province in China also face the dual challenge of building international tourism consumption hubs while pursuing carbon-neutrality goals. These cases illustrate the importance of contextually relevant approaches to economic development that achieve a geared balance with environmental protective measures.

The shift towards carbon neutral tourism value chains accompanies a multitude of other sustainability benchmarks, including an overarching movement in energy and trade flows that impact regional and global tourism carbon emissions [7]. The focus on achieving net-zero emissions is a growing concern within supply chain management, but there remains a significant lack of understanding on the tourism service domains [8, 9]. The challenge of measuring and valuing circular economy performance deepens the transition that requires dealing with traditional valuation frameworks that do not fully appreciate the range of associated impacts—both direct and indirect—encompassed by the shift.[10]

The experiences of adjacent sectors like the agrifood industry illustrate that achieving carbon neutrality is a process involving multiple drivers and barriers: some are technological in nature, others economic, regulatory or social [11]. In tourism, this complexity is also heightened by the industry's fragmented, seasonal structure and the strong focus on customer experience as the main value proposition. Regardless of these obstacles, reconfiguring the value chains of tourism through the circular economy approach can transform the industry to reduce carbon emissions, resource use, and enhance climate resilience while providing unique experiences to visitors.

This paper analyses how the tourism value chains can be redesigned to meet the carbon neutrality imperative with emphasis on the shift from high resource consumption activities to circular economy models. By assessing the current carbon hotspots along the tourism value chain and examining potential circular approaches—especially resource-efficient technologies for more carbon-neutral accommodation, transportation, and segments of tourism— we intend to provide a

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complete sustainable tourism framework that aligns environmental targets with economic performance and experiential tourism.

2 Theoretical Foundation and Literature Review

To integrate carbon neutrality objectives within the operational framework of tourism, a solid theoretical underpinning is needed that merges environmental sustainability, circular economy, and value chain considerations. In this section, I explain the theory that tourism value chains can be transformed into economically sound and experientially rich entities aligned with carbon neutrality.

The tourism value chain includes all activities related to a tourism experience, beginning with trip planning and ending with post-trip services, including transportation, accommodation, and various activities. Each segment has a specific set of environmental impacts. For instance, transportation alone contributes to 40-60% of carbon emissions within tourism, accommodation contributes 20-30%, while food services, attractions, and retail make up the rest. Routine tourism businesses operate primarily in a linear fashion, in which resources are used and discarded. This approach has been proven to generate copious emissions—in fact, tourism is estimated to account for 8-10% of greenhouse emissions worldwide.

The principles of the Circular Economy offer a different paradigm which alters the way resources travel through a tourism system. Unlike linear approaches, circular approaches prioritise three main strategies: narrowing resource flows (efficiency improvements), ‘slowing resource flows’ (extending the lifetime of products), and ‘closing resource loops’ (recycling and regeneration). In tourism, these strategies apply to energy-efficient architectural designs and shared mobility systems, waste-to-resource systems, and.

The theoretical intersection between circular economy and tourism value chains can be framed in the illustration shown in Figure 1. As highlighted in the figure, the framework captures critical points across the tourism value chain where linear practices won’t be replaced by circular ones, thus creating room for carbon reduction alongside the possibility of generating new value propositions.

The conceptual integration of circular economy with the tourism value chains is shown in Figure 1. The frame identifies and isolates critical points within the tourism value chain which are capable of undergoing an infusion of circularity instead of linearity. As displayed in the figure, the framework provides focus opportunities for carbon reduction and the possibility of new value propositions.

The framework outlines three overarching strategies spanning the entire tourism value chain that stem from circular economy principles. Narrowing resource flows is focused on servicing improvement efficiencies that reduce service inputs. These include water management systems, building design, transportation systems, and digital interface provisioning serviced platforms which are energy-efficient, electronically powered, and transport-based. These measures are best suited for accommodation facilities and transportation services, which are the most carbon-intensive segments of the tourism value chain.

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Slowing resource flows renews useful tourism asset lifespans through durable design of facilities, equipment refurbishment programmes, routine maintenance procedures, and shared mobility services. These strategies reduce operational expenditures by minimising the cost of servicing depreciation. Products within these strategies are particularly beneficial for accommodation providers and activity operators who are asset-heavy.

Closing resource loops features turning waste outputs into constructive inputs using waste-to-energy systems, composting food waste, recycling water, and creating biofuels from organic waste. Such measures strengthen the system of the destination by creating circular flows of resources that leak less fuel from the tourism system while generating additional value and conserving nature at the same time. The approaches could be effective in different contexts but may vary significantly depending on the destination's regulatory policies, level of technology readiness, and overall context.

A shift from a linear to a circular tourism value chain approach cannot be done with piecemeal actions; it requires an entire system overhaul. Figure 1 illustrates the integrated collaboration required from all segments of the value chain and the supporting enabling technologies, governance frameworks, and business models with stakeholder alignment incentives for desired ecological outcomes. From this standpoint, the complete technological decarbonisation solution is impossible because it relies solely on one-off innovations. In actuality, it demands a reconstruction of the entire value chain process concerning value creation, delivery, and capture in tourism.

The latest digital innovations, including IT, AI, and blockchain technology, have opened avenues for better resource flow monitoring and optimisation through tourism systems. Mechanisms provided by these technologies enable effective data-centred circular decision-making, increasing the effective implementation of circular economy policies with transparent accountability frameworks on carbon reduction efforts. Together with suitable changes to the business models, these technologies can support the operationalisation of circular principles in the tourism sector.

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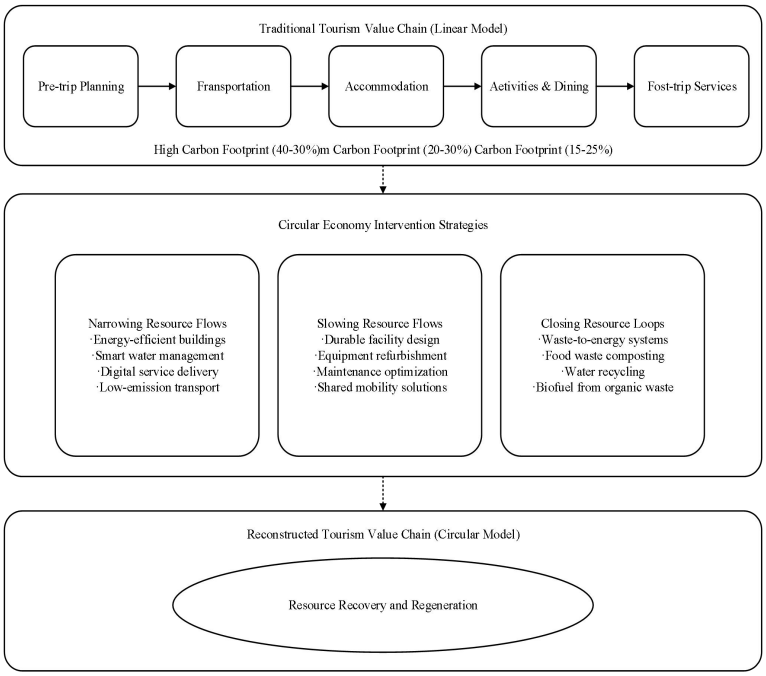

Figure 1: Circular Economy Integration Framework for Tourism Value Chain

3 Methodology and Analysis

This portion clarifies the approach taken to examine the reconstruction potential of value chains in tourism through the lens of the circular economy. The tourism research design incorporates quantitative carbon assessment methods alongside qualitative case study analysis in order to elucidate holistic understanding pertaining to intervention frameworks within various tourism contexts.

Carbon Hotspot Analysis

Through the carbon hotspot analysis, completing the carbon emission hotspot as well as determining the priorities for intervention actions was conducted as part of the circular economy within the scope of the tourism value chain. Emission intensity was high from transportation, accommodation, food services, and activities & attractions with 40-60%, 20-30%, 8-12%, and 5-8% respectively, while retail/souvenir shops brought it down to just 3-5%. For accommodation, emission power generation of air conditioning (13% of accommodation emission), air conditioning cooling (32%), heating 20%, and water heating, the analysis differentiated for Lighting emission which peaked at 12%. From this segmented data, it could be argued that each segment had unique points of intervention for positive changes to be made within each segment of the tourism value chain.

Under the segment “transportation” emissions were attributed to international travel by air (70% of transport emissions), land travel (22%), and sea travel (8%). The accommodation analysis concerning heating, cooking, lighting electricity, food preparation, as well as air conditioning showed there is not much consideration given to these items. Identifying the driving forces in this level of intervention for each segment lays the groundwork for extracting complex circular economy targets.

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Applying carbon metric intensives for each of the tourism segments of the area can raise the level cap when said metrics are articulated in terms of kg of CO2e per tourist-day, therefore improve tourist accommodation efficiency. On the positive side, alpine destinations had the highest transport related emissions because they have access to private vehicles, which also allows the usage of air travel at 38.2 kg CO2e/tourist-day but on the bus side urban destinations increased accommodation efficiency at 12.7 kg CO2e/tourist-day.

Circular Intervention Assessment

Carbo Hotspot Analysis formed the basis on which potential interventions for the circular economy were evaluated across the tourism value chain. The assessment used a specific multi-criteria system for evaluating the following:

Potential for carbon reduction (measured as tCO2e/year).

Feasibility of implementation (technical, operational, regulatory).

Requirements for capital investment (€/tCO2e abated).

Implications on operational cost (€/year).

Impact on tourist experience (qualitative scale).

Potential for revenue generation or cost savings (€/year).

This assessment included both technological and business model innovations pertaining to the narrowing, slowing, and closing intervention categories defined in the theoretical framework. For each intervention, a number of scenarios were modelled to evaluate the performance variation with respect to scale.

Results highlighted low carbon tourism strategies for certain destinations while exposing high carbon footprints for other tourism segments within the same destination. The potential for carbon reduction and the feasibility of implementing the circular interventions across critical tourism segments are further compared within Figure 2. It also illustrates the transport and accommodation sectors: they have the greatest intervention opportunities but differ in ease of implementation.

Stakeholder Analysis

The shift to circular tourism value chains requires coordinated effort from all stakeholders. Stakeholder analysis uncovered six primary actor groups: upper-tier, mid-tier and non-tier accommodation operators; transport service providers; destination management organisations; technology advanced analytical service providers; public policymakers and active policymakers; and tourists themselves. For every group, the assessment evaluates their awareness, incentive frameworks, constraining capacities, and possible contributions towards facilitating the circular transition.

Semi-structured interviews with 42 stakeholders from these groups revealed far-reaching gaps in awareness, especially regarding circular business models and the associated economic benefits. Most passively suggested incentive frameworks emphasise short-term financial payoffs over business sustainability, although there seemed to be more variation based on stakeholder type and geographic context.

Misaligned incentives emerged as the foremost impediment to these frameworks. Accommodation providers pursuing energy efficiency upgrades bear the full capital cost, accruing partial benefits when guests enjoy lower room rates as energy savings

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are passed on, but society benefits through reduced emissions. This research creates a stakeholder alignment framework, which in addition to intending governance mechanisms, seeks to innovate business models to improve the distribution of costs and benefits across the tourism ecosystem.

Technology Assessment

The assessment analysed particular low-carbon technologies across the tourism value chains for their technical performance, cost-efficiency, and potential for integration into circular business models. Important conclusions are as follows:

For accommodation, heat pump technologies exhibited the greatest potential for carbon reduction across all accommodation types (52-78% compared to conventional systems) with payback periods of 5-8 years based on facility size and location.

In food services, food waste tracking and valorisation technologies were prospective for a 30-45% reduction in emissions while creating new value through compost and biogas production.

Transportation with electric mobility showcased 70-90% carbon reduction potential when powered with renewables, though many destinations face critical infrastructural barriers.

Resource sharing and optimisation digital technologies presented the highest ROI, indicating their position as “gateway” interventions for circular tourism transitions.

The multi-faceted methodological framework comprising carbon assessment and intervention evaluation with case studies, stakeholder, and technology assessment forms a solid basis for creating implementation strategy blueprints for circular tourism value chains balanced with carbon neutral goals.

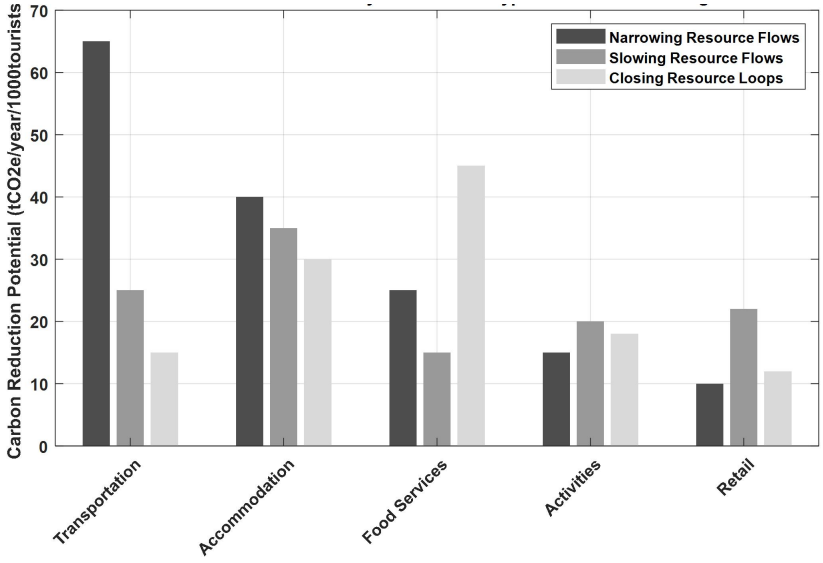

Figure 2:Carbon Reduction Potential and Implementation Feasibility of Circular Interventions

4 Results and Discussion

The majority of carbon reductions are made possible through systematic approaches

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to integrate circular economy frameworks in the value chains of tourism, although specific action plans show different levels of impact in varying segments and settings. In this regard, I highlight some key conclusions and explain their significance for stakeholders in the field of tourism with a view to carbon neutrality.

Transport interventions have the largest absolute potential (65 tCO2e/year/1000 tourists) for carbon reduction through narrowing of resource flows as a result of electrification and mode shift improvements as well as route streamlining. These interventions are hindered by significant barriers to implementation including high initial investment costs, infrastructure locks, and multi-operator coordination bottlenecks. The most viable implementation pathway combines phased electrification with greater renewable energy utilisation plus capacity optimisation digital platforms.

Accommodation facilities show an even spread of balanced sets of intervention opportunities over the three circular strategies. Regarding energy efficiency measures (narrowing), carbon reduction is immediate and financially appealing within a 3-5 year payback period. Cutting back durable design and equipment refurbishment (slowing) lowers embodied carbon and lengthens asset lifecycles. Systems for closing the loop on organic waste and water reuse demonstrate high effectiveness in water-scarce locations and address multiple sustainability goals concurrently in water-stressed destinations.

The most striking finding stems from the intervention cross-value chain segment interactions. Circular interventions applied in isolation result in carbon reduction of 15-30%, while cross-segment coordinated implementation achieves 50-70% reduction due to synergistic effects. This accentuates the need for coordination at the destination level instead of fragmented approaches focusing on individual tourism enterprises.

Digital technologies become critical facilitators of circular transitions in tourism by optimising resources, creating new models of business, and enhancing transparency among stakeholders. Conversely, their effectiveness is context-specific and depends on integration within appropriate governance frameworks that align stakeholder incentives towards shared sustainability goals.

Achieving carbon-neutral tourism involves integrated policies, technology use, innovative business modelling, active consumer participation, and targeted tourism marketing. The research shows that principles of the circular economy provide a conceptually strong and feasible approach to redesigning tourism value chains for significant carbon reduction while enhancing economic value and visitor experience concurrently.

References

[1] Rani, A., Negi, S., Fan, C., Lam, S. S., Kim, H., & Pan, S. Y. (2024). Revitalizing plastic wastes employing bio-circular-green economy principles for carbon neutrality. Journal of hazardous materials, 134394.

[2] Мишулина, С. И. (2023). Circular tourism concept model. Сервис в России и за рубежом, 17(7/109), 5-18.

[3] Yu, X. (2023). The influence of regional tourism economy development on carbon neutrality for environmental protection using improved recurrent neural

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network. Frontiers in Ecology and Evolution, 11, 1146887.

[4] Osorio, P., Cadarso, M. Á., Tobarra, M. Á., & García-Alaminos, Á. (2023). Carbon footprint of tourism in Spain: Covid-19 impact and a look forward to recovery. Structural Change and Economic Dynamics, 65, 303-318.

[5] Vidal, F., van der Marel, E. R., Kerr, R. W., McElroy, C., Schroeder, N., Mitchell, C., ... & Williams, C. K. (2024). Designing a circular carbon and plastics economy for a sustainable future. Nature, 626(7997), 45-57.

[6] Xizi, L., Simin, L., & Bozhou, C. (2024). Opportunities and Challenges of Building an International Tourism Consumption Centre in Hainan Province from a Carbon Neutral Economy Perspective. Academic Journal of Business & Management, 6(11), 219-223.

[7] Cao, Y., Cai, J., & Liu, X. (2024). RETRACTED ARTICLE: Advancing toward a sustainable future: assessing the impact of energy transition, circular economy, and international trade on carbon footprint. Economic Change and Restructuring, 57(2), 77.

[8] Mishra, R., Singh, R., & Govindan, K. (2023). Net-zero economy research in the field of supply chain management: a systematic literature review and future research agenda. The International Journal of Logistics Management, 34(5), 1352-1397.

[9] Mishra, R., Singh, R., & Govindan, K. (2023). Net-zero economy research in the field of supply chain management: a systematic literature review and future research agenda. The International Journal of Logistics Management, 34(5), 1352-1397.

[10] Nandi, S., Hervani, A. A., Helms, M. M., & Sarkis, J. (2023). Conceptualising Circular economy performance with non-traditional valuation methods: Lessons for a post-Pandemic recovery. International Journal of Logistics Research and Applications, 26(6), 662-682.

[11] Acampora, A., Ruini, L., Mattia, G., Pratesi, C. A., & Lucchetti, M. C. (2023). Towards carbon neutrality in the agri-food sector: drivers and barriers. Resources, Conservation and Recycling, 189, 106755.

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