Building Sustainable Tourism Resilience: Literature Review on Circular Food and Beverage Waste Management in Berau

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Abstract

The rapid development of tourism in Berau has significantly boosted the local economy but has simultaneously intensified environmental pressures, particularly regarding Food and Beverage (F&B) waste generation. Inadequate waste management poses a critical threat to the preservation of Berau's marine ecosystems, which serve as the primary attraction for the region. To align with the goals of a green economy, it is essential to shift from traditional linear disposal models to sustainable practices. This research aims to synthesize global best practices in circular F&B waste management and propose a strategic framework for its implementation within the tourism industry in Berau. A qualitative approach was employed through a systematic literature review of academic journals, policy reports, and industry case studies published. The analysis focuses on circular economy principles, sustainable hospitality operations, and destination resilience. The research aim to identifies effective method for waste management, including the integration of data-driven inventory systems to reduce waste at the source, the importance of multi-stakeholder collaboration among F&B businesses and local communities, and the adoption of decentralized, small-scale waste processing technologies suitable for remote tourism destinations. The study offers a conceptual framework for local stakeholders, emphasizing the transition toward a circular model that balances operational efficiency with ecological conservation. By adopting these strategies, F&B establishments in Berau can significantly contribute to the long-term resilience of the tourism sector, ensuring environmental sustainability while maintaining economic growth.

Keywords: Food Waste Management, Circular Economy, Green Economy, Tourism Resilience, Sustainable F&B, Berau.

INTRODUCTION

The tourism sector has emerged as a strategic economic driver for Indonesia, particularly in regions endowed with natural beauty and biodiversity. Berau Regency, located in East Kalimantan Province, holds a distinctive geographical position within the constellation of national and international marine tourism. The archipelago region, especially Derawan Island, Maratua Island, Sangalaki Island, and Kakaban Island, has been legally designated as a National Tourism Strategic Area due to its extraordinary marine potential and biodiversity richness (Puspitasari et al., 2024).

Derawan Island forms part of the Sulu-Sulawesi Marine Ecoregion, which traverses Indonesia, Malaysia, and the Philippines, situated at the heart of the global Coral Triangle. This region is recognized as

"The Amazon of the Oceans" due to its position as a center of marine life with abundant biodiversity. The area hosts numerous protected species, including green turtles, hawksbill turtles, whales, dolphins, giant clams, dugongs, and manta rays. Protection commitments have been strengthened through Berau Regent Decree Number 516 of 2013 concerning the Declaration of Coastal and Small Island Conservation Areas as the Derawan Islands Coastal Park (Setyasih & Helmy, 2020).

Tourism growth in Berau Regency has been remarkable, as reflected in visitor statistics. Historical data shows significant fluctuations influenced by global dynamics, including a drastic decline during the Covid-19 pandemic followed by rapid recovery. The post-pandemic surge reaching nearly 397,000 tourists in 2022 has created unprecedented ecological pressures. The growth of accommodations and restaurants without adequate waste governance threatens the destination's aesthetic image and endangers the survival of sensitive marine ecosystems (Wahyudi et al., 2023).

Existing research on sustainable tourism has extensively covered community-based approaches and economic impacts but has insufficiently addressed the integration of circular economy principles within tourism waste management, particularly in small island contexts. Studies on destination resilience focus predominantly on post-pandemic recovery without adequately incorporating environmental sustainability dimensions. Furthermore, limited attention has been given to bridging the hospitality gap among local tourism actors to foster environmental responsibility. This research addresses these gaps by proposing a comprehensive framework connecting circular waste management, green governance, and community empowerment in building resilient tourism destinations.

This study aims to formulate and analyze comprehensive strategies for building sustainable tourism destination resilience in Berau Regency through a circular F&B waste management system approach. Specifically, this research identifies and analyzes the characteristics, volume, and ecological impacts of F&B waste in coastal tourism destinations; evaluates the application of POAC-based food waste mitigation models and bioconversion technology efficiency; and analyzes the influence of green governance structures, regional regulations, and educational strategies in bridging the hospitality gap among tourism stakeholders

RESEARCH METHODOLOGY

This research employs a qualitative descriptive approach utilizing two categories of data sources. Primary data includes direct observation notes on coastal sanitation dynamics. Secondary data comprises regional waste management regulations (Berau RTRW Regulation, Waste Regulation), Berau Tourism Development Master Plan (RIPPARDA) 2016-2031, statistical data on tourist visits from BPS Berau, publications from DLHK Berau and the East Kalimantan Marine and Fisheries Department, as well as draft regional regulations on creative economy and waste management.

Criteria for informant selection are based on direct experience, institutional involvement, and authority regarding coastal tourism governance in Berau. Data collection employs three main techniques: in-depth semi-structured interviews, non-participant observation in public areas, beaches, restaurants, and accommodations on Derawan and Maratua Islands, and documentation study of written documents, historical photo archives, regulations, and relevant scientific reports.

Data analysis utilizes Interactive Model Analysis (Miles, Huberman, and Saldana, 2014) involving data reduction, data display, and conclusion drawing/verification, complemented by SWOC (Strengths, Weaknesses, Opportunities, Challenges) analysis to formulate tactical integration between internal conditions and external dynamics.

RESULTS AND DISCUSSION

Characteristics, Composition, and Ecological Impacts of Food and Beverage Waste in Berau

The urgency of waste management on Berau's small islands is critical due to the extreme disparity between domestic and commercial tourism waste volumes. Derawan Island, covering approximately 44.6 hectares, has a resident population of around 1,703 people generating average household waste of 572.95 kg/day. However, the presence of 80 non-residential buildings comprising hotels, resorts, inns, and restaurants generates massive non-household waste reaching 46.1 tons/day (approximately 46,105.1 kg/day). This phenomenon demonstrates that commercial tourism activities, particularly accommodation and culinary infrastructure, bear the greatest ecological responsibility for island environmental degradation.

Waste characteristics in coastal and island tourism areas generally consist of organic and inorganic waste. Empirical studies on similar islands such as Lemukutan Island indicate accommodation waste generation rates reaching 20,740 l/day with waste density averaging 84,670 kg/m³. Accommodation waste composition is dominated by organic waste at 44.6% and inorganic waste at 55.4%, while residential areas show 49.6% organic and 50.4% inorganic composition. The high percentage of inorganic waste in the form of single-use plastics (multilayer plastic, PET bottles, and PP cups) is significantly influenced by tourist lifestyle habits and F&B operational patterns relying on single-use plastic packaging.

Organic waste in coastal destinations is dominated by food waste from pre-consumer kitchen preparation waste and post-consumer leftover food. Indonesia nationally disposes approximately 13 million tons of food waste annually, placing the country second globally in food waste production. In the hospitality and restaurant sector, vegetables are the most frequently wasted raw food ingredients due to short shelf life, while rice is the most dominant leftover cooked food on plates. Accumulation of wet organic waste triggers rapid decomposition, producing unpleasant odors along coastlines and releasing methane gas (CH_4) with 25 times the destructive power of carbon dioxide (CO_2) in accelerating global climate change.

Table 1: Accommodation Facilities and F&B Infrastructure in Berau Regency (Main Sub-districts)

Sector	Number of Facilities	Accommodation Capacity / F&B Businesses	Average Length of Stay
Homestay	Derawan (98), Maratua (55), Biduk-Biduk (19) Total: 172 units	N/A	Domestic tourists: 2 days
Resort/Cottage	Derawan (5), Maratua (4), Biduk-Biduk (1) Total: 10 units	N/A	International tourists: 5 days
Hotel/Lodging	Tanjung Redeb (37), Derawan (26), Maratua (10) Total: 107 units	N/A	Composite: 2 to 5 days

Restaurants/Eateries	Tanjung Redeb (77), Derawan (5), Maratua (2) Total: 91 businesses	N/A	Unlimited (Daily Visitors)

Source: Berau Tourism Development Master Plan (RIPPARDA) 2016-2031

Overview of Coastal Area Waste Management Strategies in Indonesia

Waste management efforts in Indonesian tourism areas adopt various approaches highly dependent on local socio-economic characteristics and formal regional institutional involvement. Literature review reveals that various coastal tourism destinations across Indonesia implement varied operational strategies to mitigate waste accumulation impacts.

Table 2: Comparison of Coastal and Island Waste Management Models in Indonesia

Destination Location	Collection & Transportation Method	Organic Waste Processing Approach	Inorganic Waste Processing Approach	Institutional/Community Involvement
Pariaman City	Fiberglass containers with upstream sorting, motorcycle cart transportation, daily arm roll trucks	Area-scale composting at TPS 3R, coconut processing	Manual sorting, volume compaction, plastic recycling	Sanitation Department, TPS 3R managers
Parangtritis Beach	Individual storage, periodic transportation	Final disposal to Bantul Regency TPA	Final communal disposal, informal scavengers	Sanitation UPT of Tourism Department
Pulang Sawal Beach	Upstream separation by businesses at temporary disposal sites	Final communal disposal without further circular processing	Used bottle sales to collectors, souvenirs, ecological bricks	Local traders association, independent businesses
Candikusuma Beach	Self-sorting at household and coastal stall level	Household-scale composting	Plastic container size sorting, cleaning, bottle reuse	Fishermen community, PHBS education
Lemukutan Island	Communal containers with sorting, 2 motorcycle carts with compartments	Aerobic composting using open window method at area TPST	Sorting recycling, conversion to plastic pellets	150 mÂ² TPST with 4 trained workers
Derawan Island	Communal transportation from homes to Kiani Beach temporary disposal site	Centralized composting at TPS3R RUPIAH facility	Sorting, waste compacting, shipping recyclables off-island	Village Government, Berau Regency Government, WWF-Indonesia, PFON Youth

Source: Jayantri & Ridlo (2021); Wahyudi et al. (2023); WWF-Indonesia Documentation (2025)

This management comparison indicates that sanitation sustainability in isolated destinations like small islands critically depends on the availability of independent Integrated Waste Processing Facilities (TPST) within the island. Most small islands face prohibitively high logistical costs for transporting residual waste to the mainland, making upstream sorting and on-site conversion of waste into economically valuable products the only financially viable solution. On Derawan Island, previous waste governance failures in the early 2010s were caused by broken choppers and composters due to the absence

of skilled local operators and lack of sustainable operational budgets. This condition led to the initiative of building TPS3R RUPIAH (Derawan Waste Sorting House) in late 2025 through tripartite collaboration between Berau Regency Government, Derawan Village Government, and WWF-Indonesia to create an integrated community-based circular system.

Best Practice Learning: POAC-Based Food Waste Management Model

To formulate a comprehensive food waste mitigation framework for the F&B industry in Berau Regency, this literature review adopts learning from empirically proven best practices at Oolaa Bar and Restaurant in Kuta Lombok, West Nusa Tenggara. The ala carte restaurant successfully reduced food waste significantly through integration of POAC functional management (Planning, Organizing, Actuating, Controlling) with Triple Bottom Line (TBL) sustainability principles.

Table 3: POAC Implementation and Triple Bottom Line Achievements for F&B Waste Management

POAC Stage	Operational Description and Mitigation Mechanisms	Relationship with Triple Bottom Line Dimensions	Real Impact on Restaurant Performance
Planning	Food waste management training program planning for staff; kitchen food waste analysis; flexible menu portion planning	Economic (Profit): Minimizing excess raw material purchases; kitchen logistics procurement efficiency	Decrease in food cost percentage against revenue
Organizing	Food waste management team formation; pre-consumer food material supervision role assignment to Head Chef	Social (People): Building collective responsibility and accountability structure in the kitchen	Consistent daily coordination; elimination of overlapping wet waste handling
Actuating	Kitchen, bar, and dining area waste sorting implementation; Eco-Enzyme production from fruit peels; surplus food donation	Environmental (Planet): Organic waste diversion from final disposal; carbon footprint reduction	Conversion of meat leftovers into pizza toppings; cleaning liquid from bar citrus waste
Controlling	Daily waste weight monitoring with inspection checklists; periodic evaluation of reduction target achievement	Business Integration: Ensuring system sustainability and regular identification of procedural constraints	30% food waste volume reduction in first three operational months

Source: Sudirman et al. (2024)

This POAC model demonstrates that systematic food waste handling from the operational upstream can transform waste management costs into operational savings that increase restaurant profit margins. These savings subsequently provide financial space for companies to fund social responsibility programs, such as advanced employee training and donation of edible food to local communities in need. This integration is highly relevant for replication by 91 restaurant and eatery units spread across coastal areas of Berau Regency to measurably reduce organic waste leakage into sensitive marine waters.

Circular Technology and Bioconversion Applications in Berau Regency

F&B organic waste processing efforts in Berau Regency have entered an innovation phase through bioconversion technology utilizing natural decomposer organisms, particularly Black Soldier Fly (Hermetia illucens). On Maratua Island, with a population of approximately 3,927 people and a study-based area of 4,119.54

km², a research team from the School of Life Sciences and Technology, Bandung Institute of Technology (SITH ITB) led by Agus Dana Permana pioneered BSF cultivation programs to address the threat of organic waste accumulation in coastal hotels, resorts, and restaurants. The community service program, initiated in 2021, constructed a pilot-scale 3 x 4 x 3 meter BSF fly rearing cage in Payung-Payung Village.

Biologically, Hermetia illucens larvae act as highly aggressive and efficient organic decomposers. BSF larvae can decompose various types of tourism food waste faster than microorganisms or earthworms. Through the bioconversion process, larvae consume organic food waste and transform it into nutrient-rich body biomass. BSF prepupa biomass contains crude protein ranging from 36% to 43% and crude fat from 26% to 30%, making it an ideal supplementary feed ingredient to reduce feed costs in native chicken (Gallus domesticus) and layer chicken farming developed by local Pokdarwis. Additionally, residual growth media in the form of decomposed maggot frass produces "Kasgot" (maggot residue), a high-quality organic fertilizer ready for use by local horticultural farmers to enrich soil structure on small islands.

Another circular innovation developing in Berau coastal areas is the processing of shrimp heads previously discarded by fishermen as worthless fishery waste in Pegat Batumbuk Village. Through a mentoring program by the Berau Fisheries Department in collaboration with the Indonesian Nature Conservation Foundation (YKAN), coastal women's groups are empowered to process shrimp head waste into high-value snacks branded "Uludang Crispy," marketed at Rp 25,000 per 100-gram package. This shrimp head waste utilization not only mitigates odor pollution at fishing ports but also converts organic residue into alternative income sources that improve the economic resilience of traditional fishing families.

Regulatory Synergy, Green Governance, and the Hospitality Gap

Advanced circular technology implementation will not yield sustainable impact without support from strong green governance structures and sustainability commitment at both corporate and regional government levels. Green governance encompasses institutional regulations that encourage strict environmental oversight, suppress opportunistic management behavior, and reduce environmental information asymmetry through transparent sustainability reporting. Empirical studies in the ASEAN region show that environmental disclosure quality is significantly influenced by internal corporate governance structures.

Table 4: Synthesis of Green Governance Framework Influence on Sustainability Report Quality

Internal Governance Element	Impact on Environmental Disclosure Quality (SRQ)	Mechanism and Moderating Role of Sustainability Commitment
Board Size	Moderately positive influence on report reliability aspects	Large boards provide professional background diversity in calculating operational waste risks
Board Independence Proportion	Significant negative influence on clarity and conciseness aspects	Independent non-executive members tend to focus on direct shareholder

		oversight rather than voluntary public disclosure
Gender Diversity (Female Directors)	Very strong and significant positive influence on all report quality dimensions	Female directors demonstrate higher concern for pollution, climate change issues, and democratic communication patterns
Sustainability Commitment Presence	Acts as main moderating variable strengthening female director influence on sustainability report quality	Real commitment in the form of social cost allocation converts governance oversight into tangible environmental action

Source: Chairina & Tjahjadi (2023)

In the socio-cultural context of Berau Regency, the main obstacle in achieving destination environmental cleanliness is the existence of a hospitality gap among local tourism actors. Most tourism business operators, government officials, and local communities have biased understanding, where they better understand the concept of technical service rather than genuine hospitality. Technical service is narrowly understood as mechanical performance based on minimum work standards—such as escorting guests, serving food, or cleaning hotel rooms as job obligations. Meanwhile, genuine hospitality involves warmth, sincerity, deep respect between host and guest, and collective moral responsibility to maintain destination ecosystem sustainability as a shared home.

This hospitality gap explains why many accommodation managers and restaurant owners in Berau ignore waste accumulation along coastlines outside their commercial property areas. They consider waste handling on beaches and seas outside hotel walls to be the exclusive responsibility of local government or beach cleaning personnel whose numbers are very limited. This narrow view triggers the phenomenon of coastal environmental degradation at favorite destinations like Kaniungan Island, now filled with domestic waste, leftover food, and coconut husks due to the proliferation of street vendors and unregulated accommodations.

Environmental psychology education shows that tourist and business actors' intentions to reduce food waste are not influenced by general environmental concern attitudes but are highly determined by feeling personal responsibility and specific knowledge about waste sorting procedures. Thus, intervention programs in Berau Regency should be directed toward training that reconstructs tourism actors' identity from mere "mechanical service providers" to "responsible hosts" for their destination's ecological safety.

Post-Pandemic Regional Regulatory Synergy and Collaborative Action

Building Berau's tourism ecological resilience requires integration between community behavioral awareness and firm formal regulatory instruments. In line with the East Kalimantan Provincial Government's target to achieve 100% waste management by 2030, Berau Regency still faces significant challenges as waste management achievement in 2024 only reached 29.69% of total waste generation. The gap between increasing tourist numbers and inadequate waste management infrastructure, combined with limited operational funding for TPS3R facilities, remains the main bottleneck.

Strategic opportunities to accelerate circular transition include: the passing of regional regulations on waste management and creative economy currently being deliberated by the Berau DPRD; global trends in circular eco-tourism attracting environmentally conscious high-end tourists; and proven bioconversion technology applications and circular food donation programs that demonstrably improve local community economies.

CONCLUSION

Building sustainable tourism destination resilience in Berau Regency faces dual challenges: physical damage from beach abrasion and increasing commercial F&B waste generation risking ecological carrying capacity overload of small islands. This literature review proves that the transition toward sustainable tourism cannot rely on linear end-of-pipe disposal approaches. Tourism ecosystem restoration success critically depends on integrating systematically planned upstream-downstream circular models.

Adoption of POAC-based circular management practices (Planning, Organizing, Actuating, Controlling) can convert cooked food waste from restaurant plates into real operational savings strengthening the economic pillar of the Triple Bottom Line. The successful operation of the TPS3R RUPIAH Derawan facility in reducing plastic waste, the success of ITB in engineering bioconversion of restaurant waste using Black Soldier Fly larvae as high-protein animal feed on Maratua, and the success of shrimp head waste processing into "Uludang Crispy" culinary products in Pegat Batumbuk constitute concrete evidence that F&B waste can be reintegrated into Berau's productive economic chain.

External challenges include physical damage threats from beach abrasion on Derawan Island potentially destabilizing resort buildings and coastal settlements; microplastic accumulation threats in the sea damaging sensitive green turtle nesting habitats; and regional budget uncertainty (waste budget) for funding additional cleaning personnel in outermost island destinations.

To accelerate this circular transition, Berau Regency Government needs to strengthen institutional governance through the enactment of Waste Management Regional Regulations and enforcement of strict fine sanctions for violators in conservation areas. Furthermore, environmental socialization should focus on eroding the "hospitality gap" among regional tourism actors. By training tourism actors to understand hospitality as an ethical responsibility to care for nature and welcome guests with sincerity, circular waste sorting actions will transform from mere regulatory compliance into an integral part of Berau's coastal community social and cultural identity.

RECOMMENDATION

Based on the analysis findings and literature comparison, several strategic recommendations are proposed to strengthen Berau's tourism ecosystem resilience:

1. For Berau Tourism and Culture Department (Disbudpar): Immediately enact Regent Regulation regarding single-use plastic restrictions in the hospitality sector with progressive sanctions for violators, and integrate circular waste management modules into Pokdarwis capacity-building training programs.

2. For Berau Environment and Forestry Department (DLHK): Allocate special

budgets to support additional cleaning personnel in outermost island tourism destinations (Derawan and Maratua), and facilitate procurement of area-scale composters for hotels and restaurants to reduce organic waste before entering TPST facilities.

3. For Horeka Business Actors (Hotels, Restaurants, Cafes): Consistently adopt the POAC waste management framework by training kitchen staff in upstream sorting and separation, and establish partnerships with local animal feed providers or BSF maggot cultivation units to channel wet food waste.

4. For Pokdarwis and Youth Communities: Optimize daily environmental education programs for tourists, monitor waste sorting compliance at TPS3R RUPIAH facilities, and continue collaboratively campaigning for the "Desir Pasir" movement and the national "Bulan Cinta Laut" program.

ACKNOWLEDGMENTS

The authors express sincere gratitude to the Berau Regency Government, particularly the Tourism and Culture Department and the Environment and Forestry Department, for providing access to data and documentation. Special appreciation is extended to WWF-Indonesia, the ITB research team, the Sumping Nusa and Payung-Payung Pokdarwis, and all informants who contributed valuable insights to this research.

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