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Lentera model a mixed-methods validation of a hybrid framework for circular waste governance in Bali tourism destination

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Abstract. This study aims to validate LENTERA model as a comprehensive framework for advancing circular waste governance in tourism destinations (Purpose). The LENTERA construct comprising Local Knowledge, Education, Networking, Technology, Environmental Care, Reduce of Waste, and Action is conceptualized as a set of dynamic capabilities that enable Circular Economy Adoption and strengthen Sustainable Tourism Governance. Despite growing attention to circularity in tourism, empirical evidence that integrates cultural embeddedness, technological adoption, and governance mechanisms remains limited, indicating a research gap addressed in this study. A sequential explanatory mixed-methods design was applied. The quantitative phase surveyed 100 tourism stakeholders and employed Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess reliability, predictive relationships, and effect sizes among the LENTERA constructs. The qualitative phase included 28 in-depth interviews and two focus group discussions to contextualize and explain the statistical outcomes. The findings indicate that all seven LENTERA pillars significantly influence Circular Economy Adoption ($R^2 = 0.64$), which strongly predicts Sustainable Tourism Governance outcomes ($R^2 = 0.48$). Waste reduction, action mechanisms, and technology demonstrated the strongest predictive power and represent critical leverage points for system transformation. Qualitative insights further reveal that cultural legitimacy rooted in indigenous values such as Tri Hita Karana enhances stakeholder acceptance and operational compliance. This study provides theoretical advancement and a validated decision-support tool for policymakers, tourism operators, and destination managers seeking to transition toward circular tourism systems.

Keywords. circular economy adoption, sustainable tourism governance, waste management in tourism, PLS-SEM analysis, tourism policy and practice

1. Introduction

Bali, Indonesia's globally renowned tourism destination celebrated for its cultural heritage and natural landscapes (Mudana *et al.*, 2024), is increasingly confronted with a sustainability paradox. While tourism remains the island's primary economic driver, the rapid increase in visitor numbers and expansion of hospitality infrastructure have accelerated waste generation far beyond the capacity of its conventional linear collect–transport–dispose system. Wang *et al.* (2021) identify four critical governance gaps rigid institutional arrangements, unsynchronized stakeholder roles, weak inter-organizational coordination, and limited technological and human resource capacities that undermine effective waste management in tourism-dependent island contexts. These gaps are strongly reflected in Bali's current situation,



intensified after the closure of the Susiung Final Disposal Site, reaffirming the need for a more adaptive, collaborative, and circular-economy-oriented model of waste governance.

This challenge is not unique to Bali but reflects a broader global struggle. As highlighted by Kurniawan *et al.* (2022), waste governance in many developing regions continues to be hampered by fragmented policies, limited technological integration, and inconsistent multi-actor participation, which collectively constrain the transition towards Circular Economy (CE) practices. In tourism-intensive destinations, these structural deficiencies are exacerbated, leading to severe environmental stress. Empirical evidence from tourism-intensive islands reaffirms this structural vulnerability. Martins and Cró (2021) demonstrate that rising tourist arrivals in Madeira Island consistently and significantly increase municipal solid waste generation, revealing a persistent dependence on linear resource flows that fail to absorb tourism-induced pressures. This pattern underscores a critical warning for Bali: without systemic adoption of circular practices, higher visitation will continue to amplify waste burdens despite ongoing policy interventions.

Within the Balinese context, community-based institutions like the *banjar* and its regulations (*perarem*) have historically played a pivotal role in shaping pro-environmental behaviour and managing local affairs. However, the modern tourism economy often operates in a separate sphere. Recent empirical research indicates that rapid tourism expansion and the dominance of hotel and restaurant industries frequently evolve outside local socio-cultural governance systems. Studies demonstrate that traditional institutions such as community-based customary governance structures struggle to maintain regulatory influence over waste-producing hospitality actors, resulting in fragmented policy execution and weak compliance. This governance disconnect has been observed in various tourism regions, where the institutional authority and cultural legitimacy of traditional bodies are bypassed as commercial tourism interests become more dominant, creating critical governance gaps in waste regulation and environmental stewardship (Juvan *et al.*, 2023; Ally, 2024; Suasih, 2024).

Conceptually, advancements in circular tourism argue that a successful CE transition requires a place-based ecosystem where cultural values, technological capabilities, and institutional coordination are synergistically reinforced (Manniche *et al.*, 2021). Yet, practical implementation remains a significant hurdle. Empirical evidence from Indonesian metropolitan contexts shows that community-based waste systems often struggle with limited innovation capacity, inadequate monitoring mechanisms, and fragmented coordination among stakeholders, conditions that similarly undermine the effectiveness of circular economy initiatives. Sari *et al.* (2020) note that such systemic weaknesses particularly the lack of integrated community, government collaboration frequently impede the scalability and long-term impact of waste management programs, a challenge that resonates with Bali's efforts to operationalize sustainable waste governance.

This synthesis reveals a substantive evidence gap in the existing literature. While technological fixes, community governance, and cultural frameworks have often been studied in isolation, there is a lack of research that systematically integrates these dimensions into a unified, actionable model capable of driving CE adoption across a complex, tourism-based ecosystem like Bali. Specifically, previous studies have not cohesively connected local cultural values, capacity-building initiatives, inter-organizational networking, appropriate technology, environmental stewardship, waste reduction behaviors, and operational action within a single empirical framework.

Responding to this gap, the present study introduces and empirically tests the **LENERA Model**, a hybrid framework comprising seven interlinked pillars: **L**ocal Knowledge, **E**ducation, **N**etworking, **T**echnology, **E**nvironmental Care, **R**educe of Waste, and **A**ction. This model is positioned as a set of dynamic capabilities designed to enable CE

contexts. It synthesizes the socio-cultural dimensions: (1) cultural–institutional values rooted in *Tri Hita Karana* philosophy; (2) modular and scalable technological solutions such as TPS3R (Tempat Pengolahan Sampah Reduce, Reuse, Recycle) and biodigesters; and (3) tourism-driven circular mechanisms, including Green Levies and hotel-based sustainability units.

Three research objectives guide this study: (1) to assess the individual and collective influences of the seven LENTERA pillars on the adoption of CE practices; (2) to examine the effects of CE adoption on sustainable tourism outcomes; and (3) to identify strategic performance gaps to inform future governance and managerial interventions for a circular tourism ecosystem in Bali.

This paper is structured as follows: The following section presents a literature review and the theoretical basis underlying the LENTERA Model, leading to the development of hypotheses. The next section describes the mixed-methods approach used to capture the socio-technical complexities of waste governance in Bali. The Results section reports the empirical findings. The Discussion section discusses theoretical and practical implications. The final section presents recommendations, limitations, and future research directions.

2. Literature review and hypothesis development

2.1. Beyond fragmentation: The case for a hybrid approach

Current waste management in tourism destinations like Bali is characterized by a fundamental paradox. While community-based models, such as the *banjar*, are heralded as pillars of sustainability, empirical evidence suggests these initiatives often operate below their full potential and face serious institutional capacity challenges (Prasetyo and Hadi, 2021). This gap is exacerbated by the dynamics of the global tourism economy, where tourism as a major waste generator frequently functions in a separate sphere and remains formally disintegrated from customary and local governance arrangements, resulting in fragmented approaches to waste-stream management (Wang, Lee, & Mokhtar, 2021; Nguyen, 2022). More profoundly, local wisdom and cultural values that could serve as socio-environmental adhesives for example *Tri Hita Karana* in Bali are often marginalized or underutilized in contemporary waste policy and practice, limiting opportunities to align community norms with hospitality sector behaviour and waste reduction initiatives (Ally *et al.*, 2024). This situation reveals a dissociation between local knowledge systems, community institutional capacity, and dominant tourism economic actors. The LENTERA Model is designed to bridge these interconnected gaps through an integrated, hybrid approach.

2.2. Theoretical anchoring: Resource-based view and dynamic capabilities

This study is anchored in the Resource-Based View (RBV) and Dynamic Capabilities theory. From an RBV perspective, Balinese cultural values such as *Tri Hita Karana* constitute valuable, rare, and imperfectly imitable resources that can underpin a destination's sustainable competitive advantage (Barney, 1991). Complementing this, Elkington *et al.* (2020) emphasize that dynamic capabilities, particularly the ability to sense, seize, and reconfigure socio-cultural and technological assets are essential for achieving sustainability-oriented transformation. Their insights reinforce how destinations like Bali must continually adapt and redeploy cultural, institutional, and technological competencies to confront rapidly evolving environmental pressures, including escalating waste management challenges.

2.3. The lentera framework and hypotheses development

The LENTERA framework conceptualizes culturally embedded dynamic capabilities as antecedents that enable tourism and hospitality organizations to transition toward Circular Economy (CE) systems. Each pillar: Local Knowledge, Education, Networking, Technology,



strengthened organizational readiness for circular transformation. Building on theoretical foundations and empirical evidence, this section presents the study's hypotheses.

Local knowledge → CE adoption (H1)

Local knowledge encompasses place-based values, cultural practices, and ecological ethics that shape sustainability-oriented decision-making. The integration of such indigenous wisdom has been shown to enhance the implementation of circular approaches. This is supported by research in the manufacturing sector, which found that a "developmental culture" defined as an organizational context grounded in shared values, trust, and a commitment to continuous learning acts as a critical enabler for successfully implementing Circular Economy principles in conjunction with Industry 4.0 technologies (Piyathanavong *et al.*, 2024). The integration of local wisdom has been shown to enhance the implementation of circular approaches in various sectors, including tourism. This suggests that culturally-grounded knowledge serves as a fundamental enabler for CE transitions in destination contexts.

H1: Local Knowledge has a positive effect on CE adoption.

Education → CE adoption (H2)

Education fosters the cognitive, technical, and behavioural competencies needed for CE implementation. Research indicates that comprehensive training programs significantly improve waste management practices in hospitality settings (Filimonau *et al.*, 2020). Environmental education has been identified as a critical factor in shifting organizational behavior toward circular practices, particularly in resource-intensive industries.

H2: Education has a positive effect on CE adoption.

Networking → CE adoption (H3)

Networking plays a critical role in advancing Circular Economy adoption through strategic collaboration, resource mobilization, and cross-stakeholder knowledge exchange. Recent studies highlight that multi-actor collaboration encompassing government agencies, industry practitioners, academia, communities, and business networks serves as a key enabler for accelerating the implementation of circular business models. Empirical evidence from Narayana *et al.* (2024) confirms that networking capabilities significantly enhance organizational readiness for Circular Economy adoption by providing access to relevant technologies, material resources, and best practices. These findings reinforce the notion that collaborative networks constitute a strategic foundation for organizations seeking to accelerate their transition toward the Circular Economy.

H3: Networking has a positive effect on CE adoption.

Technology → CE adoption (H4)

Technological capability plays a pivotal role in accelerating the transition toward a Circular Economy by enhancing monitoring capacity, material traceability, and operational efficiency. Recent research demonstrates that the adoption of technology including digitalization, resource-tracking systems, and automation serves as a primary enabler in strengthening circular processes and supporting the redesign of operational systems toward greater sustainability. Empirical evidence from Carlos (2024) indicates that the utilization of digital technologies significantly reinforces Circular Economy practices by improving transparency in material flows, optimizing resource usage, and strengthening data-driven decision-making processes. This evidence underscores the strategic role of technology in fostering Circular Economy adoption across multiple sectors, including the hospitality and tourism industry.



Environmental care → CE adoption (H5)

Environmental concern reflects pro-environmental values, attitudes, and orientations that underpin sustainability commitments. Recent empirical evidence in the tourism context suggests that levels of environmental awareness and concern function as key psychological drivers influencing both organizations and individuals to adopt sustainable practices and shift from linear systems toward Circular Economy models. Zorpas (2021) emphasizes that environmental motivation including ecological awareness and responsibility for operational impacts significantly affects the readiness and willingness of tourism industry actors to implement Circular Economy strategies. This evidence reinforces the argument that environmental concern serves as a fundamental catalyst for Circular Economy adoption.

H5: Environmental Care has a positive effect on CE adoption.

Reduce of waste → CE adoption (H6)

Waste-reduction capability reflects the ability to minimize resource loss at the earliest stages of operational processes, making it one of the primary drivers of transformation toward a Circular Economy (CE). Recent empirical findings indicate that waste reduction efforts function not only as an environmental compliance strategy, but also as a strategic capability that accelerates CE adoption by improving resource efficiency, optimizing operational performance, and supporting the achievement of sustainability goals. Howard *et al.* (2022) empirically confirm that waste-reduction practices serve as a foundational mechanism enabling organizations to shift from linear systems to circular systems by strengthening material-flow control, increasing reuse potential, and reinforcing systemic thinking within organizational processes. This evidence strengthens the argument that waste-reduction capability contributes directly to accelerating the adoption of Circular Economy practices.

H6: Reduce of Waste has a positive effect on CE adoption.

Action → CE adoption (H7)

Action reflects the translation of sustainability commitments into concrete initiatives, policies, and operational execution. Recent studies indicate that sustainability practices generate meaningful impact only when translated into concrete actions such as material-system redesign, the use of renewable resources, and measurable operational process changes (Blomsma, 2022). Empirical findings within the framework of the Circular Economy Action Plan further demonstrate that the adoption of CE increases significantly when organizations integrate operational actions through standards, incentives, and compliance mechanisms that drive a shift from symbolic commitments to measurable circular practices (Spani, 2020). This evidence reinforces the argument that the implementation of strategic action constitutes a critical factor in accelerating Circular Economy adoption in the tourism sector, including destination governance systems and the hospitality industry.

H7: Action has a positive effect on CE adoption.

CE adoption → Sustainable tourism outcomes (H8)

The adoption of Circular Economy (CE) practices is increasingly regarded as a key driver for achieving sustainable tourism outcomes, particularly as destinations shift from a linear model toward regenerative and closed-loop systems. Recent empirical studies demonstrate that CE-based tourism models enhance environmental protection, strengthen cultural preservation, and generate local economic value through resource efficiency and innovation (Rudan, 2023). Post-pandemic tourism governance findings further indicate that CE frameworks support environmental recovery and resilience through waste reduction, product



of circular business models within destinations (Borysova *et al.*, 2022). Case-based research in rural tourism villages and heritage sites confirms that CE implementation reinforces destination branding, improves resource circularity, and contributes directly to sustainability targets through eco-innovation and community engagement (Wahyudi *et al.*, 2023).

H8: Circular Economy adoption has a positive effect on sustainable tourism outcomes.

The final step is hypothesis testing. The results of the hypothesis testing are presented in Figure 1.

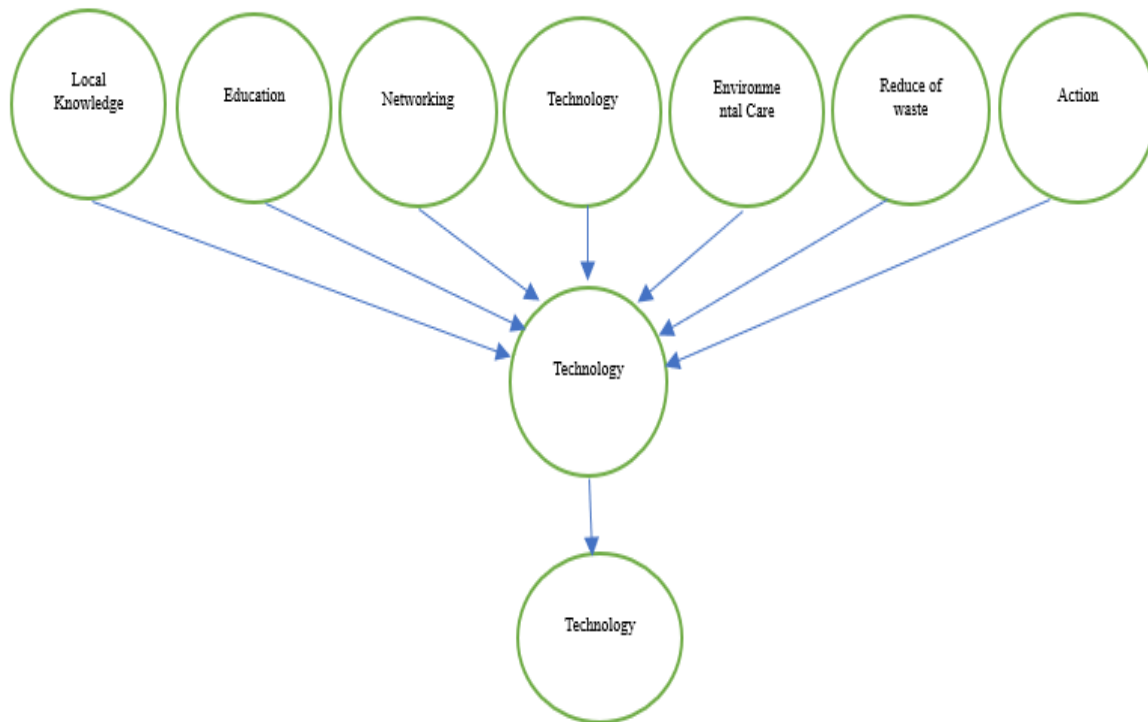


Figure 1: The LENTERA conceptual framework

3. Methodology

3.1 Research design and sampling

This study employed a sequential explanatory mixed-methods design, aligning with methodological recommendations for examining complex, multi-stakeholder frameworks in circular economy and tourism research (Rasoolimanesh *et al.*, 2021). This two-phase approach was specifically chosen to first quantitatively test the hypothesized LENTERA model, followed by a qualitative investigation to explain the quantitative findings and explore the contextual mechanisms underlying waste management dynamics in Bali (Fetters, 2020).

The study was conducted in Kuta, Bali, a mature mass-tourism destination characterized by high waste generation, a diverse stakeholder ecosystem, and documented challenges of policy and initiative fragmentation (Dharmawan *et al.*, 2023). This context makes it an ideal empirical setting for testing the applicability of the integrated LENTERA framework. A multi-stakeholder sample of 100 respondents was recruited using a stratified random sampling technique to ensure representation across key actor groups in the tourism waste management system:

- Hotel Managers (n=25)
- Hotel Staff (n=30)
- Banjar (Community) Representatives (n=25)

The sample size was determined using G*Power software for a medium effect size ($f^2 = 0.15$), 80% power, and $\alpha = 0.05$, and exceeded the minimum requirement for Partial Least Squares (PLS) analysis based on the '10-times rule' (Hair *et al.*, 2020).

For the qualitative phase, purposive sampling was used to select 30 key informants with a minimum of five years of experience in Bali's tourism or waste management sectors. Data saturation was achieved through 28 in-depth interviews and two Focus Group Discussions (FGDs).

3.2. Measures and instrument development

All constructs in the LENTERA framework were measured reflectively using 7-point Likert scales. The survey instrument was developed through a rigorous four-stage process: (1) initial item generation (45 items) based on a comprehensive literature review and contextualization to the Balinese tourism setting; (2) expert validation involving two academic researchers and two local waste management practitioners (Content Validity Index = 0.89); (3) pilot testing (n=30); and (4) reliability assessment, where all constructs demonstrated Cronbach's Alpha values > 0.70 in the pilot study.

The operationalization of each construct was specifically adapted to the Balinese context and grounded in the literature reviewed in Chapter 2:

- **Local Knowledge (H1):** Measured using four items adapted from Pál (2022), this construct emphasizes that the Circular Economy is inherently embedded within social and cultural contexts. As highlighted by Pál (2022), the transition toward an inclusive and sustainable Circular Economy requires a context-sensitive approach in which community solidarity, cultural values, and shared practices play a critical role in shaping circular systems. Therefore, the integration of Tri Hita Karana principles and *banjar*-based regulations in community waste management is not only conceptually relevant but also empirically grounded as an example of culturally embedded circular practices. Waste management is implemented with consideration of local cultural values, including Tri Hita Karana.
- **Education (H2):** Assessed through five items adapted from Filimonau *et al.* (2020), measuring the implementation of educational programs for tourists and staff training in hospitality establishments (e.g., "Our hotel provides regular waste separation training for all staff members").
- **Networking (H3):** Evaluated using four items derived from Rasoolimanesh *et al.* (2021), examining the intensity and quality of collaboration among pentahelix stakeholders (e.g., "Our banjar has formal partnerships with local hotels for waste collection and processing").
- **Technology (H4):** Measured with five items adapted from Kurniawan *et al.* (2022), focusing on the adoption and perceived suitability of modular, context-appropriate waste processing technologies (e.g., "Small-scale waste-to-energy technology is suitable for our community's needs").
- **Environmental Care (H5):** This construct was measured using four items adapted from Cop *et al.* (2020), focusing on assessing organizational environmental commitment within the hospitality industry context. As demonstrated by Cop *et al.* (2020), environmental commitment reflecting the collective attitudes, motivations, and dedication of an organization toward environmental protection is a key driver of sustainable environmental practices. Accordingly, this construct effectively captures



sustainability-oriented values within hotel organizational settings and local communities. Environmental protection is considered a critical factor in shaping organizational practices and policies.

- Reduce Waste (H6): Evaluated using four items derived from Filimonau *et al.* (2020), measuring the implementation of 3R (Reduce, Reuse, Recycle) strategies, particularly targeting single-use plastics (e.g., "Our hotel has successfully reduced single-use plastic consumption by more than 50% in the past year").
- Action (H7): Measured with five items adapted from Prasetyo and Hadi (2021), assessing the implementation of concrete governance mechanisms and policy instruments (e.g., "Our banjar has implemented clear sanctions for improper waste disposal").
- Circular Economy Adoption: The dependent variable was measured using a multi-dimensional scale capturing the implementation of circular practices across environmental, economic, and social dimensions.
- Sustainable Tourism Outcomes: Outcome measures were adapted from Rasoolimanesh *et al.* (2021), assessing environmental quality, economic benefits, and social wellbeing.

3.3. Data analysis

Quantitative data were analyzed using variance-based Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4 software. This analytical approach was selected due to the model's predictive orientation, complexity, and the study's focus on theory development in an emerging research context (Hair *et al.*, 2020). PLS-SEM is particularly suitable for testing the LENTERA framework as it accommodates complex models with multiple constructs and does not require normally distributed data.

The analysis followed a two-stage approach: first assessing the measurement model for reliability and validity, then evaluating the structural model for hypothesis testing. Bootstrapping with 5,000 resamples was conducted to determine the significance of path coefficients. The study employed advanced analytical techniques including PLSpredict to assess the model's out-of-sample predictive power and Importance-Performance Map Analysis (IPMA) to identify priority areas for intervention.

For the qualitative analysis, transcribed interview and FGD data were analyzed using NVivo 14 software. Thematic analysis was conducted through a systematic process of coding, category development, and theme identification. Methodological rigor was ensured through triangulation of data sources and member checking with key informants. The qualitative findings provided rich contextual insights that explained and elaborated the quantitative results, particularly regarding the implementation mechanisms of the LENTERA pillars in the Balinese context.

This integrated analytical approach enabled a comprehensive examination of both the "what" (quantitative relationships) and the "how/why" (qualitative mechanisms) of the LENTERA framework's operation in Bali's distinctive tourism ecosystem.

4. Results

4.1. Measurement model assessment

Table 1 presents the reflective measurement model results for the LENTERA framework. All constructs demonstrated strong reliability and validity in accordance with established guidelines (Hair *et al.*, 2020). Outer loadings exceeded the 0.70 threshold, composite reliability (CR) values surpassed 0.80, and the average variance extracted (AVE) was greater than 0.50 for all constructs, confirming convergent validity. Specifically, the high

Local knowledge construct indicated that the instrument successfully captured the application of Tri Hita Karana principles within Bali's waste management context.

Table 1: Measurement model results of the LENTERA framework

Construct	Indicator Range	Outer Loading	Cronbach's α	CR	AVE	HTMT
Local Knowledge (L)	LK1-LK4	0.72-0.87	0.86	0.90	0.67	0.78
Education (E)	ED1-ED4	0.73-0.88	0.85	0.89	0.66	0.79
Networking (N)	NW1-NW3	0.75-0.91	0.87	0.91	0.72	0.82
Technology (T)	TC1-TC4	0.74-0.89	0.88	0.92	0.70	0.81
Environmental Care (EC)	EC1-EC4	0.74-0.88	0.85	0.91	0.69	0.83
Reduce of Waste (R)	RW1-RW3	0.78-0.90	0.86	0.92	0.71	0.80
Action (A)	AC1-AC4	0.77-0.89	0.88	0.93	0.72	0.84
Circular Economy (CE)	CE1-CE4	0.76-0.91	0.89	0.93	0.70	0.82
Sustainable Tourism (ST)	ST1-ST4	0.75-0.90	0.90	0.94	0.73	0.81

Note: All HTMT values were below the 0.85 threshold, confirming discriminant validity (Henseler *et al.*, 2015). All model fit indices met recommended cut-offs (SRMR = 0.061 < 0.08), indicating adequate model fit (Hair *et al.*, 2020).

4.2. Structural model and hypothesis testing

Bootstrapping with 5,000 subsamples was conducted to test the significance of the hypothesized relationships. The sample size met the adequacy criterion following the "10-times rule."

The results revealed that all LENTERA dimensions positively contributed to circular economy development, which in turn significantly enhanced sustainable tourism performance. Technology ($\beta = 0.27, p < 0.001$) and Reduce of Waste ($\beta = 0.28, p < 0.001$) emerged as the strongest predictors of Circular Economy adoption, confirming findings by Kurniawan *et al.* (2022) regarding the importance of appropriate technology in island contexts.

Table 2: Structural model and hypothesis testing results

Hypothesis	Path	β	t-value	p-value	f ²	Decision
H1	Local Knowledge → CE	0.22	4.15	0.000	0.07	Supported
H2	Education → CE	0.19	3.82	0.000	0.06	Supported
H3	Networking → CE	0.24	4.76	0.000	0.09	Supported
H4	Technology → CE	0.27	5.03	0.000	0.11	Supported
H5	Environmental Care → CE	0.20	3.91	0.000	0.08	Supported
H6	Reduce of Waste → CE	0.28	5.41	0.000	0.13	Supported
H7	Action → CE	0.25	4.94	0.000	0.10	Supported



The model explained 64% of the variance in Circular Economy ($R^2 = 0.64$) and 48% in Sustainable Tourism ($R^2 = 0.48$), confirming strong predictive capability (Hair *et al.*, 2020). Effect sizes (f^2) ranged from 0.06 (small) to 0.25 (medium), while predictive relevance ($Q^2 = 0.37$ for CE and $Q^2 = 0.25$ for ST) validated the model's explanatory power (Sarstedt *et al.*, 2022).

To enhance the managerial relevance of the findings, Importance-Performance Map Analysis (IPMA) was conducted. The results identified Technology, Reduce of Waste, and Action as the most influential levers for circular economy optimization in Bali's sustainable tourism development.

Table 3: IPMA results of LENTERA dimensions

Construct	Importance	Performance	Strategy Priority
L-local Knowledge	0.33	71.2	Medium
E-education	0.30	68.5	Medium
N-networking	0.36	66.9	High
T-technology	0.42	63.1	High
E-environmental Care	0.35	65.7	Medium
R-reduce of Waste	0.44	60.8	High
A-action	0.41	62.3	High

The IPMA results indicate that while Reduce of Waste demonstrated the highest importance (0.44), it showed the lowest performance (60.8), suggesting a significant implementation gap. Conversely, Local Knowledge showed the highest performance (71.2) despite moderate importance, reflecting the deeply embedded strength of Balinese local wisdom.

4.3. Integration of qualitative findings

The qualitative phase provided deeper insights into how LENTERA dimensions operate in real-world hospitality and tourism settings in Bali. Thematic analysis revealed four key themes:

Theme 1: The integration of *Tri Hita Karana* values and *banjar* regulations into sustainability practices emerged as a crucial source of social legitimacy. As noted by one participant, "*Banjar regulations on waste separation based on Tri Hita Karana make the program more acceptable compared to government regulations alone*" (Hotel Manager, 15 years of experience). This finding not only supports the quantitative results for H1 but also reinforces recent scholarship emphasizing the role of culture as a foundational element in sustainable tourism governance, where local values provide a strong normative framework and legitimacy for environmental policy implementation (Ha Nguyen Thi *et al.*, 2024).

Theme 2: Technology-Community Fit: Technology adoption was constrained by technical capacity gaps but could be addressed through hybrid approaches. "Modular composting machines are suitable for small hotels, but require repeated staff training," (Engineering Manager). This explains why Technology showed high importance but low performance in the IPMA.

Theme 3: Collaborative Governance in Action: Multi-stakeholder networks addressed fragmentation through practical coordination mechanisms. "Collaboration among 15 hotels in the Kuta area enables us to collect plastic waste in economically viable volumes for recycling," (Waste Bank Manager). This finding reinforces H3 results and corresponds with Rasoolimanesh *et al.* (2022).

Theme 4: From Awareness to Measurable Action: Education integrated with reward systems enhanced program effectiveness. "The e-Waste Bali application turns waste separation into a healthy competition between departments, with immediately visible impacts." (Housekeeping Staff).

An inter-coder agreement of 0.83 confirmed thematic coding reliability. Data were analyzed using NVivo 14, with triangulation and member checking employed to enhance credibility.

This study provides robust empirical evidence that the LENTERA model offers an integrative and contextually embedded framework for advancing circular economy (CE) implementation in the tourism sector of Bali. Grounded in the principles of Dynamic Capabilities Theory (Schilke *et al.*, 2018), the findings confirm that the seven LENTERA pillars function as antecedent capabilities that enable destinations to reconfigure resources for sustainability transitions.

The strong relationship between Technology and Circular Economy ($\beta = 0.27$, $p < 0.001$) reinforces contemporary technology adoption frameworks that emphasize contextual fit and

usability in developing regions (Kurniawan *et al.*, 2022). In this case, digital waste monitoring tools became catalysts for operational efficiency and accountability, suggesting that digital transformation is not merely a technical solution but also a social innovation that redefines value creation.

The influence of Local Knowledge and Environmental Care underscores the relevance of place-based sustainability approaches, as affirmed by Vila *et al.* (2022), who highlight that effective circular economy transitions in tourism must be grounded in local socio-cultural contexts and supported by community-driven governance arrangements. In the Balinese context, integrating Tri Hita Karana enhances the legitimacy and social acceptance of waste reduction practices, demonstrating how the LENTERA framework localizes sustainability principles in culturally resonant and operationally feasible ways.

Furthermore, the positive and significant pathway from Circular Economy to Sustainable Tourism ($\beta = 0.55$, $p < 0.001$) affirms the contemporary sustainability paradigm that environmental efficiency directly enhances socio-economic resilience and destination reputation (Rasoolimanesh *et al.*, 2022). This empirical linkage positions circularity as a key mechanism for achieving long-term tourism competitiveness.

From a managerial perspective, the LENTERA model offers actionable insights for hotels, communities, and policymakers seeking to transition toward sustainable tourism operations.

1. Technology and Action as Priority Levers: IPMA results indicate that Technology and Action have the highest strategic importance. Sustainability initiatives should emphasize digital integration (e.g., real-time waste tracking apps) and participatory action programs involving both employees and guests.
2. Local Wisdom as Cultural Legitimacy: Strengthening Local Knowledge through community-based education and customary regulations can ensure behavioural alignment and long-term compliance. Integrating Tri Hita Karana values into operational standards promotes environmental care as a moral duty, emphasizing its role as the philosophical foundation for sustainable tourism and waste management in Bali (Dharmawan *et al.*, 2023).
3. Networking as the Engine of Collaboration: The importance of Networking reflects the necessity of multi-stakeholder partnerships among hotels, local government, waste entrepreneurs, and NGOs. These alliances can co-create value through joint recycling programs and waste-to-wealth initiatives.
4. Education as Transformational Capital: Continuous education from staff training to guest awareness campaigns should be embedded as a behavioural transformation mechanism, aligning with contemporary sustainability education approaches (Filimonau *et al.*, 2020).

Collectively, these strategies suggest that circular tourism requires "learning ecosystems" where each LENTERA dimension acts as a torch (*lentera*) illuminating the pathway toward sustainability.

At the policy level, the findings advocate for a place-based circular economy approach where sustainability policies are co-created with local communities rather than imposed top-down. The Balinese experience demonstrates that when sustainability frameworks respect local traditions, adoption and enforcement become naturally embedded.

Moreover, by linking Reduce of Waste and Action to measurable tourism outcomes, the LENTERA model supports Indonesia's national targets for waste reduction (Perpres No. 97/2017) and sustainable tourism (SDG 12). It provides a replicable blueprint for other island destinations facing similar environmental and socio-cultural complexities.

While the present study offers substantial insights, further exploration could refine the LENTERA model in several ways:

1. Expanding the sample to include multiple destinations (e.g., Lombok, Labuan Bajo) to assess external validity.
2. Employing longitudinal mixed-methods designs to track behavioural and policy changes over time.
3. Integrating environmental performance indicators (e.g., carbon footprint, waste diversion rate) to quantify sustainability outcomes.
4. Testing the mediating role of stakeholder trust or policy compliance between LENTERA constructs and circular economy performance.

These directions will deepen the theoretical and practical contribution of LENTERA as a scalable model for circular tourism transformation across developing regions.

Conclusions

This study successfully introduced and empirically validated the LENTERA model as an integrated framework to address the critical challenge of fragmented waste governance in Bali's tourism sector. The findings demonstrate that the seven LENTERA pillars function as a synergistic system of dynamic capabilities that significantly drive Circular Economy adoption, which in turn proves to be a decisive mechanism for achieving Sustainable Tourism outcomes.

The model's theoretical contribution lies in its integration of Resource-Based View and Dynamic Capabilities, showing how cultural elements like *Tri Hita Karana* become valuable, rare, and difficult-to-imitate resources when effectively reconfigured with technological and institutional capabilities. The empirical results confirm that all hypothesized relationships are significant, with the model explaining 64% of variance in Circular Economy adoption and 48% in Sustainable Tourism outcomes.

The IPMA findings provide crucial strategic guidance, identifying Technology, Reduce of Waste, and Action as high-importance, lower-performance levers that offer the greatest potential for intervention impact. Meanwhile, the strong performance of Local Knowledge demonstrates the power of cultural embeddedness in the Balinese context.

By moving beyond siloed approaches, LENTERA provides a validated, context-sensitive blueprint that bridges the gap between centralized systems and community initiatives. It demonstrates that the transformation toward circular tourism requires neither purely top-down nor bottom-up approaches, but rather a hybrid governance model that leverages cultural strengths while addressing technological and operational gaps.

While this study provides robust validation of the LENTERA model, several limitations should be acknowledged. The research context is specific to Bali's unique cultural and tourism ecosystem, which may affect immediate generalizability. The cross-sectional nature of the quantitative data, while enriched by qualitative insights, limits causal inferences over time.

Future research should address these limitations through:

1. **Cross-contextual Validation:** Comparative studies in other island destinations (e.g., Lombok, Phuket) to test the model's transferability and identify contextual moderators.
2. **Longitudinal Assessment:** Tracking the evolution of LENTERA capabilities and their impact on circular economy performance through longitudinal mixed-methods designs.
3. **Methodological Enhancement:** Incorporating objective environmental metrics (waste audits, carbon footprint) to complement perceptual measures and strengthen outcome validation.
4. **Technological Integration:** Exploring the role of emerging technologies like AI for waste optimization and blockchain for circular supply chain transparency, building on the high strategic importance of the Technology pillar.

The LENTERA framework ultimately represents more than a waste management model it embodies a paradigm shift toward integrated, culturally-grounded, and dynamically adaptive approaches to sustainable tourism transformation. As destinations worldwide grapple with the challenges of overtourism and environmental degradation, this research contributes both a practical toolkit and a theoretical foundation for building more resilient tourism ecosystems.

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