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The Effect of Circular Economy Practices on Sustainable Tourism Development Among Tourism and Hospitality Enterprises Around Simien Mountains National Park in Ethiopia

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Abstract

Circular economy practices have become increasingly important for promoting sustainable tourism by reducing resource consumption, minimizing waste, strengthening local resource use, and encouraging innovative tourism products and services. However, tourism and hospitality enterprises in developing destinations often face challenges in adopting circular practices due to limited infrastructure, financial resources, technical capacity, and institutional support. This study examined the relationship between circular economy practices and sustainable tourism development among tourism and hospitality enterprises around Simien Mountains National Park, Ethiopia. A cross-sectional research design was employed, and data were collected from tourism and hospitality enterprises using a structured questionnaire. A total of 305 usable questionnaires were analyzed using descriptive statistics and multiple linear regression analysis. The study examined six dimensions of circular economy practices: resource reduction and efficiency, reuse practices, recycling and waste recovery, sustainable procurement, renewable energy and resource conservation, and circular product and service innovation. The findings revealed that the overall regression model was statistically significant, $F(6, 298) = 68.236$, $p < .001$, with the six circular economy practices jointly explaining 57.9% of the variation in sustainable tourism development. Circular product and service innovation ($\beta = .552$, $p < .001$), sustainable procurement ($\beta = .303$, $p < .001$), reuse practices ($\beta = .261$, $p < .001$), and resource reduction and efficiency ($\beta = .102$, $p = .041$) were positively and significantly associated with sustainable tourism development. In contrast, recycling and waste recovery ($\beta = -.143$, $p = .032$) and renewable energy and resource conservation ($\beta = -.238$, $p = .001$) showed statistically significant negative associations within the fitted model. These findings suggest that circular economy practices are important predictors of sustainable tourism development, although their relationships differ across dimensions and may reflect contextual implementation conditions. The study provides practical implications for tourism and hospitality enterprises, local government, park authorities, and other stakeholders to strengthen circular product and service innovation, sustainable procurement, resource efficiency, reuse systems, recycling infrastructure, and renewable-energy initiatives. The findings can contribute to the development of more resource-efficient, environmentally responsible, economically viable, and resilient tourism practices around Simien Mountains National Park..

1. Introduction

The tourism and hospitality sector serves as a vital economic engine in developing countries, driving regional employment, foreign exchange earnings, and community livelihoods. However, the sector is inherently resource-intensive, generating substantial ecological footprints through massive consumption of water, energy, and raw materials, along with significant outputs of food waste, single-use plastics, and greenhouse gas emissions (Ellen MacArthur Foundation, 2015; Strippoli et al., 2024). In response to growing environmental degradation, the Circular Economy (CE) has emerged as an essential alternative to the conventional linear "take–make–dispose" economic paradigm. By prioritizing resource efficiency, material life extension, waste elimination, and closed-loop systems, circular strategies enable service destinations to decouple economic growth from ecological degradation (Rodríguez-Antón & Alonso-Almeida, 2019; Strippoli et al., 2024).

Within the hospitality and tourism domain, transitioning toward circularity requires a multi-dimensional operational commitment. Micro-level enterprises including hotels, restaurants, tour operators and lodges interact continuously with local supply chains and environmental ecosystems. Adoption of practices such as resource consumption reduction, material reuse, waste recovery, sustainable procurement, renewable energy transition, and circular service innovation can significantly enhance operational sustainability (Strippoli et al., 2024). Nevertheless, implementing circular strategies remains particularly challenging in peripheral and developing destinations, where enterprises encounter acute capital constraints, underdeveloped waste-processing infrastructure, limited technical expertise, and weak institutional support (Tomassini et al., 2025). As Tomassini et al. (2025) argue, circular tourism research remains theoretically and empirically underdeveloped, requiring holistic evaluations across interconnected micro, meso, and macro scales.

The necessity for circular operational models is heightened in environmentally sensitive, protected-area destinations, such as Simien Mountains National Park (SMNP) in Ethiopia. Designated as a UNESCO World Heritage site, SMNP possesses unique biodiversity and fragile high-altitude ecosystems that attract international nature-based tourism. However, expanding hospitality operations surrounding the park exert severe pressure on local water tables, fuel wood resources, agricultural systems, and inadequate waste management infrastructure. In such ecologically vulnerable settings, sustainable tourism development hinges on balancing enterprise viability with strict environmental conservation and community benefit-sharing.

Despite the growing body of literature on circular hospitality, critical empirical gaps persist. First, much of the existing scholarship remains conceptual or focuses isolated attention on single practices—such as municipal solid waste management or energy efficiency rather than evaluating circularity as a integrated, multi-dimensional system (Tomassini et al., 2025). Second, empirical evidence examining the joint impact of diverse circular practices on Sustainable Tourism Development (STD) remains virtually non-existent in Sub-Saharan Africa, particularly within protected-area buffer zones. While environmental conservation and sustainable tourism have received policy attention in Ethiopia, empirical research has yet to quantify how enterprise-level circular practices simultaneously influence overall destination sustainability.

To address these gaps, this study examines the empirical relationship between multidimensional circular economy practices and Sustainable Tourism Development among tourism and hospitality enterprises surrounding Simien Mountains National Park, Ethiopia. Specifically, this study evaluates six key dimensions: (1) Resource Reduction and Efficiency, (2) Reuse Practices, (3) Recycling and Waste Recovery, (4) Sustainable Procurement, (5) Renewable Energy and Resource Conservation, and (6) Circular Product and Service Innovation. By providing contextual empirical insights from a protected-area destination, this paper contributes to the circular tourism literature and offers actionable guidelines for park administrators, hospitality managers, and regional policymakers seeking to align tourism operations with long-term ecological resilience

2. Theoretical Framework and Hypotheses Development

2.1 Theoretical Foundations

This study integrates Circular Economy (CE) Theory (Ellen MacArthur Foundation, 2015) and the Natural-Resource-Based View (NRBV) of the firm (Barney, 1991; Hart, 1995) to construct a multidimensional model explaining Sustainable Tourism Development (STD). Circular Economy Theory posits that transitioning from linear "take–make–dispose" economic systems toward closed-loop operations maximizing resource efficiency, material longevity, waste recovery, and systemic innovation—decouples business growth from environmental degradation (Rodríguez-Antón & Alonso-Almeida, 2019; Strippoli et al., 2024). Complementarily, NRBV extends strategic management theory by asserting that firm performance and competitive advantage in environmentally constrained settings depend on three interconnected capabilities: pollution prevention, product stewardship, and sustainable development (Hart, 1995).

In the context of peripheral, protected-area destinations like Simien Mountains National Park (SMNP), circular economy practices function as critical organizational capabilities. Enterprise-level investments in closed-loop systems enable hospitality firms to mitigate localized resource scarcity, reduce operational overhead, strengthen supply-chain resilience, and foster destination-level sustainability. However, as Tomassini et al. (2025) note, circular capabilities are non-monolithic; their execution varies significantly across individual operational dimensions.

2.2 Hypotheses Development

2.2.1 Resource Reduction and Efficiency

Resource reduction and efficiency involve minimizing input throughput (energy, water, raw materials, food) while preserving service quality. Aligned with pollution prevention capabilities under NRBV, efficiency practices reduce operational waste at the source and lower input costs (Rodríguez-Antón & Alonso-Almeida, 2019). In fragile high-altitude ecosystems like SMNP, reducing unnecessary consumption directly mitigates ecological degradation. Thus, researchers propose:

H1

Resource Reduction and Efficiency is significantly and positively associated with Sustainable Tourism Development.

2.2.2 Reuse Practices

Reuse practices extend product lifecycles through repurposing, refurbishing, and repeated utilization of equipment, containers, and furnishings without major reprocessing. Extending material lifespans reduces primary extraction demands and solid waste generation (Strippoli et al., 2024). In remote hospitality contexts, maintaining operational resources in productive use serves as an accessible, low-cost circular mechanism. Thus, researchers propose:

H2

Reuse Practices are significantly and positively associated with Sustainable Tourism Development.

2.2.3 Recycling and Waste Recovery

Recycling involves sorting, collecting, and reprocessing secondary materials into viable operational inputs (Geissdoerfer et al., 2017; Strippoli et al., 2024). By diverting waste streams from landfills, waste-recovery systems preserve natural capital and support closed-loop material flows (Ellen MacArthur Foundation, 2015). Although the operational efficacy of recycling depends heavily on regional processing infrastructure and municipal waste management capacity (Rodríguez-Antón & Alonso-Almeida, 2019; Tomassini et al., 2025), proactive waste-recovery capabilities are theoretically expected to enhance enterprise-level environmental performance and destination sustainability. Thus, researchers propose:

H3

Recycling and Waste Recovery is significantly and positively associated with Sustainable Tourism Development.

2.2.4 Sustainable Procurement

Sustainable procurement integrates environmental and socio-economic criteria into supply-chain purchasing, prioritizing durable, locally produced, low-packaging, and ethically sourced inputs. Grounded in NRBV product stewardship (Hart, 1995), green procurement extends enterprise environmental boundaries into the broader local economy, building resilience and community linkages around protected areas. Thus, researchers propose:

H4

Sustainable Procurement is significantly and positively associated with Sustainable Tourism Development.

2.2.5 Renewable Energy and Resource Conservation

According to Strippoli et al. (2024) and Rodríguez-Antón and Alonso-Almeida (2019), renewable energy adoption (e.g., solar photovoltaic, solar thermal) and active resource conservation significantly reduce enterprise dependency on non-renewable grid utilities and localized biomass or fuel wood consumption. In fragile protected-area destinations, transitioning to decentralized clean energy sources mitigates greenhouse gas emissions and relieves surrounding deforestation pressures while simultaneously bolstering long-term energy security for hospitality firms (ICIMOD, 2022; Nepal et al., 2019). Thus, researchers propose:

H5

Renewable Energy and Resource Conservation are significantly and positively associated with Sustainable Tourism Development.

2.2.6 Circular Product and Service Innovation

Circular product and service innovation entails holistic business model redesign—re-engineering hospitality packages, service delivery, and customer experiences around closed-loop principles (Tomassini et al., 2025). As a dynamic capability, circular innovation integrates environmental stewardship into core competitive strategy, generating superior economic and socio-ecological value. Thus, researchers propose:

H6

Circular Product and Service Innovation is significantly and positively associated with Sustainable Tourism Development.

2.3. Conceptual Framework

The conceptual framework (Fig. 1.1) illustrates the hypothesized relationships between multidimensional Circular Economy Practices (CEPs) and Sustainable Tourism Development ($\text {STD} $) in the context of tourism and hospitality enterprises operating around Simien Mountains National Park (SMNP). Grounded in the Natural-Resource-Based View (NRBV) and Circular Economy Theory, the model conceptualizes circular economy adoption not as a singular operational tactic, but as a set of six distinct organizational capabilities:

Circular economy practices

Independent Variables

Resource Reduction and Efficiency (RRE)

Reuse Practices (RP)

Sustainable Tourism Development (STD)

Recycling and Waste Recovery (RWR)

Sustainable Procurement (SP)

Renewable Energy and Resource Conservation (RERC)

Circular Product and Service Innovation (CPSI)

Figure 1.1: Conceptual Framework of Circular Economy Practices and Sustainable Tourism Development (Constructed by authors, 2026).

3. Methods and Materials

A cross-sectional explanatory research design was employed to examine the relationships between circular economy practices and sustainable tourism development among tourism and hospitality enterprises around Simien Mountains National Park (SMNP), Ethiopia. A quantitative research approach was adopted to assess the extent to which circular economy practices are associated with sustainable tourism development. The study focused on six dimensions of circular economy practices: resource reduction and efficiency, reuse practices, recycling and waste recovery, sustainable procurement, renewable energy and resource conservation, and circular product and service innovation. Sustainable tourism development was considered the dependent variable.

The target population comprised tourism and hospitality enterprises operating in and around Simien Mountains National Park, including hotels, lodges, restaurants, tour operators, and other relevant tourism-related businesses. Managers, owners, and permanent employees who had sufficient experience and direct knowledge of their organizations' operational and environmental practices were considered appropriate respondents. Enterprises and respondents without adequate knowledge of their organization's resource-use, waste-management, procurement, energy, and sustainability practices were excluded from the study. This approach ensured that the respondents had direct exposure to the circular economy practices being examined.

A sampling procedure was employed to identify tourism and hospitality enterprises and respondents participating in the study. From the selected enterprises operating around SMNP, a total of 305 usable questionnaires were obtained and included in the final analysis. Appropriate sampling procedures were used to ensure that respondents with relevant knowledge and experience of circular economy practices and sustainable tourism operations were represented. The final sample size provided sufficient observations for conducting descriptive, correlation, and multiple regression analyses involving the six explanatory variables.

Data were collected using a structured questionnaire consisting of five-point Likert-type items ranging from 1 = strongly disagree to 5 = strongly agree. The questionnaire was developed and adapted from relevant literature on circular economy, sustainable tourism, environmental management, resource efficiency, waste management, sustainable procurement, renewable energy, and circular innovation. The questionnaire was organized into sections measuring the six dimensions of circular economy practices and sustainable tourism development. Before the main data collection, the instrument was reviewed to ensure that the items were clear, relevant, and appropriate to the tourism and hospitality context around SMNP.

The collected data were coded and analyzed using Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize the characteristics of respondents and the level of circular economy practices and sustainable tourism development. Pearson correlation analysis was used to examine the direction and strength of the relationships between the independent variables and sustainable tourism development. In addition, multiple linear regression analysis was employed to examine the combined predictive relationship between the six circular economy dimensions and sustainable tourism development and to test the proposed hypotheses. The regression model included resource reduction and efficiency, reuse practices, recycling and waste recovery, sustainable procurement, renewable energy and resource conservation, and circular product and service innovation as independent variables.

The validity and reliability of the research instrument were also assessed before conducting the main analysis. To enhance content and face validity, the questionnaire was reviewed by researchers and experts with relevant knowledge of tourism, hospitality, environmental management, and research methodology. Ambiguous, unclear, or repetitive items were revised based on the feedback received. A pilot test was conducted before the final data collection to identify problems related to wording, sequencing, and comprehension of the questionnaire items.

The reliability of the questionnaire was evaluated using Cronbach's Alpha coefficient to determine the internal consistency of the measurement items. A Cronbach's Alpha value of 0.70 or above was considered an acceptable level of internal consistency for the study. The reliability results indicated that the measurement items demonstrated acceptable internal consistency, supporting their use for subsequent statistical analysis.

Table 1
Measurement reliability

Variables	No. of Items	Cronbach's Alpha value
resource reduction and efficiency	6	0.701
reuse practices	6	0.714
recycling and waste recovery	6	0.721
sustainable procurement	6	0.792
renewable energy and resource conservation	6	0.710
circular product and service innovation	5	0.810
sustainable tourism development	7	0.715
Source: (Survey result, 2026)		

4. Results

4.1. Respondents' Characteristics

The demographic characteristics indicate that the respondents had diverse personal and occupational backgrounds. Most respondents were married (59.0%), followed by single respondents (33.1%), while 5.2% were divorced and 2.6% widowed. Regarding work experience, 35.7% had 1–5 years of experience, 30.8% had 6–10 years, and 24.3% had more than 10 years, whereas 9.2% had less than one year. Thus, the majority had at least one year of experience in tourism and hospitality operations, suggesting adequate familiarity with enterprise practices relevant to the study. In terms of monthly salary, 31.5% earned 3,001–5,000 Ethiopian birr, 28.5% earned 5,001–7,000 birr, 22.3% fell within the fifth salary category, and 17.7% earned 1,501–3,000 birr. Overall, the respondents represented a workforce with varied socioeconomic characteristics and substantial practical experience, providing an appropriate basis for assessing circular economy practices and their relationship with sustainable tourism development.

Table 2
respondents' profile

Variables	Categories	Total No of respondents	
		Frequency	Percent (%)
Gender	Female	139	45.6
	Male	166	54.4
	Total	305	100
Age	18–24	24	7.9
	25–34	100	32.8
	35–44	90	29.5
	> 45	91	29.8
	Total	305	100
Educational status	Preparatory	37	12.1
	Diploma	109	35.7
	Degree	121	39.7
	Masters and above	38.1	12.5
Experience of the respondents	< 1 year	28	9.2
	1–5 year	109	35.7
	6–10 year	94	30.8
	more than 10 years	74	24.3
	Total	305	100.0
salary of the employee	1501–2000	25	8.2
	2001–3000	29	9.5
	3001–5000	96	31.5
	5001–7000	87	28.5
	> 7000	68	22.3
	Total	305	100.0
Source: (Survey, 2026)			

4.2 Inferential Statistics

4.2.1Correlation Analysis

Pearson correlation analysis was conducted to examine the strength and direction of the linear relationships between the six dimensions of circular economy practices—resource reduction and efficiency (RRE), reuse practices (RP), recycling and waste recovery (RWR), sustainable procurement (SP), renewable energy and resource conservation (RERC), and circular product and service innovation (CPSI)—and sustainable tourism development (STD) among tourism and hospitality enterprises around Simien Mountains National Park. Pearson's correlation coefficient (r) was used to assess the magnitude and direction of the relationships, with statistical significance evaluated at the 5% level ($p < 0.05$). Positive correlations indicate that higher levels of circular economy practices are associated with higher levels of sustainable tourism development.

Table 3
; Correlation analysis result between predictors and dependent variables.

Correlations									
		resource reduction and efficiency	**reuse practices**	**recycling and waste recover**	**sustainable procurement**	**renewable energy and resource conservation**	**circular product and service innovation**	**sustainable tourism development**	**Work Environment**
sustainable tourism development	Pearson Correlation	.528**	.613**	.561**	.592**	.550**	.710**	1	.710**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	0.000		.000
**. Correlation is significant at the 0.01 level (2-tailed).									
Source: (Researcher own survey, 2026)									

The correlation analysis revealed that all six dimensions of circular economy practices were positively and significantly associated with sustainable tourism development (STD). Resource Reduction and Efficiency (RRE) showed a moderate positive correlation with STD **(**r = .528, p < .001**)**, indicating that greater efficiency in the use of materials, water, energy, and other resources was associated with higher levels of sustainable tourism development. Reuse Practices (RP) demonstrated a stronger positive association **(**r = .613, p < .001**)**, followed by Sustainable Procurement (SP) **(**r = .606, p < .001**)** and Recycling and Waste Recovery (RWR) **(**r = .561, p < .001**)**. Renewable Energy and Resource Conservation (RERC) was also positively correlated with STD **(**r = .550, p < .001**)**. The strongest association was observed between Circular Product and Service Innovation (CPSI) and STD **(**r = .710, p < .001**)**, indicating a strong bivariate relationship between circular innovations in tourism products and services and sustainable tourism development. Overall, the findings suggest that stronger implementation of circular economy practices is associated with higher levels of sustainable tourism development among tourism and hospitality enterprises around SMNP. However, these bivariate correlations indicate association rather than causation; the relative predictive contribution of each dimension should therefore be assessed using the multiple regression analysis.

4.2.2 Multi- Collinearity

Multi-collinearity could be controlled and checked in two ways: tolerance value and variance of the factor (VIF). A tolerance value less than 0.1 and a VIF value greater than 10 indicate a co-linearity problem (Field, 2009).

Table 4
; Collinearity Statistics of the Independent Variables

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	Resource Reduction and Efficiency	.574	1.743
	Reuse Practices	.425	2.355
	Recycling and Waste Recovery	.321	3.114
	Sustainable Procurement	.319	3.138
	Renewable Energy and Resource Conservation	.259	3.860
	Circular Product and Service Innovation	.280	3.573
a. Dependent Variable: Sustainable Tourism Development			

Source: (Researcher own survey, 2026)

The multicollinearity diagnostics indicated that tolerance values ranged from 0.259 to 0.574, while variance inflation factor (VIF) values ranged from 1.743 to 3.860. All tolerance values exceeded 0.10 and all VIF values were below 5.00, indicating that multicollinearity was not a serious concern among the six independent variables. Although Renewable Energy and Resource Conservation showed the highest VIF (3.860) and lowest tolerance (0.259), these values remained within acceptable limits. Thus, the predictors were considered sufficiently distinct for inclusion in the multiple regression models.

Table 5
Model summary result

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.761[a]	.579	.570	.26675	1.810
a. Predictors: (Constant), resource reduction and efficiency reuse practices, recycling and waste recovery, sustainable procurement, renewable energy and resource conservation, and circular product and service innovation, and the dependent variable. .					
b. Dependent Variable: sustainable tourism development					

Source: (Researcher own survey, 2026)

A multiple linear regression using the Enter method evaluated the collective effect of six circular economy practices; Circular Product and Service Innovation, Resource Reduction and Efficiency, Reuse Practices, Sustainable Procurement, Recycling and Waste Recovery, and Renewable Energy and Resource Conservation on Sustainable Tourism Development. The predictors exhibited a strong positive relationship with the dependent variable (R = 0.761). Collectively, the model explained 57.9% of the variance in Sustainable Tourism Development (R2 = 0.579, Radj2 = 0.570, SEE = 0.267), with the minor shrinkage between R2 and Radj2confirming model stability. Finally, a Durbin–Watson statistic of 1.810 indicated no critical autocorrelation among the residuals, satisfying the assumption of independence.

Table 6
ANOVA-test result

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	29.132	6	4.855	68.236	.000b
a. Dependent Variable: Sustainable Tourism Development						
b. Predictors: (Constant), Circular Product and Service Innovation, Resource Reduction and Efficiency, Reuse Practices, Sustainable Procurement, Recycling and Waste Recovery, Renewable Energy and Resource Conservation.						

Source: (Researcher own survey, 2026)

The statistical significance of the multiple regression models was evaluated using Analysis of Variance (ANOVA). The model was statistically significant, F (6,298) = 68.236, p < 0.001, with a regression sum of squares of 29.132 (MS = 4.855). This confirms that the six circular economy practices Resource Reduction and Efficiency, Reuse Practices, Recycling and Waste Recovery, Sustainable Procurement, Renewable Energy and Resource Conservation, and Circular Product and Service Innovation collectively account for a statistically significant proportion of variance in Sustainable Tourism Development. The null hypothesis that all regression coefficients are simultaneously equal to zero was rejected.

4.2.6. Model Coefficients Summary

Table 7
ANOVA-test result

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.393	.145		9.591	.000		
	Resource Reduction and Efficiency	.092	.045	.102	2.057	.041	.574	1.743
	Reuse Practices	.191	.042	.261	4.530	.000	.425	2.355
	Recycling and Waste Recovery	− .107	.050	− .143	-2.152	.032	.321	3.114
	Sustainable Procurement	.237	.052	.303	4.555	.000	.319	3.138
	Renewable Energy and Resource Conservation	− .173	.054	− .238	-3.228	.001	.259	3.860
	Circular Product and Service Innovation	.414	.053	.552	7.769	.000	.280	3.573
a. Dependent Variable: Sustainable Tourism Development. Source: (Researcher's Own Survey, 2026)								

The multiple linear regression models were specified as: STD = β0 + β1X1 + β2X2 + β3X3 + β4X4 + β5X5 + β6X6+ϵ

Where STD represents Sustainable Tourism Development, and X1through X6denote Resource Reduction and Efficiency, Reuse Practices, Recycling and Waste Recovery, Sustainable Procurement, Renewable Energy and Resource Conservation, and Circular Product and Service Innovation, respectively (ϵ denotes the error term).

All six circular economy dimensions were statistically significant predictors at the = 0.05 level. Standardized beta coefficients (β) revealed that Circular Product and Service Innovation made the strongest positive relative contribution (β = 0.552, t = 7.769, p < 0.001), followed by Sustainable Procurement (β = 0.303,t = 4.555,p < 0.001), Reuse Practices (β = 0.261,t = 4.530,p < 0.001), and Resource Reduction and Efficiency (β = 0.102,t = 2.057,p = 0.041).

Conversely, Renewable Energy and Resource Conservation (β=−0.238, t = − 3.228,p = 0.001) and Recycling and Waste Recovery (β=−0.143,t = − 2.152,p = 0.032) yielded significant negative coefficients. These inverse parameter estimates reflect partial conditional relationships within the multivariate model structure rather than indicating that recycling or renewable energy inherently hinders sustainable development.

Based on the unstandardized coefficients (B), the fitted empirical regression equation is:

STD = 1.393 + 0.092X1 + 0.191X2 − 0.107X3 + 0.237X4 − 0.173X5 + 0.414X6

Holding all other variables constant, a one-unit increase in Circular Product and Service Innovation yields the largest positive change in Sustainable Tourism Development (B = 0.414), while Renewable Energy and Resource Conservation (B = − 0.173) and Recycling and Waste Recovery (B = − 0.107) exhibit negative incremental changes.

4.2.7 Residual Diagnostics and Model Assumptions

Table 8
ANOVA-test result

Residuals Statistics[a]					
	Minimum	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	3.0657	4.6253	3.9667	.30956	305
Residual	− .82643	.61633	.00000	.26410	305
Std. Predicted Value	-2.911	2.128	.000	1.000	305
Std. Residual	-3.098	2.311	.000	.990	305
a. Dependent Variable: Sustainable Tourism Development					

Source: (Researcher's Own Survey, 2026)

Predicted Values: The unstandardized predicted scores for Sustainable Tourism Development ranged from 3.066 to 4.625 (M = 3.967, SD = 0.310). Standardized predicted values ranged from − 2.911 to 2.128 (M = 0.000, SD = 1.000). Residual Distributions: Unstandardized residuals ranged from − 0.826 to 0.616 (M = 0.000, SD = 0.264), satisfying the expected zero-mean assumption of Ordinary Least Squares (OLS) estimation. Standardized residuals ranged between − 3.098 and 2.311 (M = 0.000, SD = 0.990). Outlier & Diagnostic Assessment: Nearly all standardized residuals fell comfortably within the standard acceptable threshold of ± 3.0. A single extreme value slightly exceeded this bound (Std. Residual = − 3.098). Diagnostic checks (including visual inspection of the normal P–P plot, residual scatterplots, and Cook's distance metrics) confirmed that this solitary case did not exert undue leverage or distort overall model stability. Overall, the residual properties demonstrate model adequacy, unbiased estimation, and adherence to key OLS distributional assumptions.

4.3 Discussion of Findings

This study evaluated the empirical relationship between circular economy (CE) practices and Sustainable Tourism Development (STD) among tourism and hospitality enterprises surrounding Simien Mountains National Park (SMNP), Ethiopia. The overall regression model demonstrated strong explanatory power (F (6,298) = 68.236,p < 0.001,R2 = 0.579), indicating that circular practices collectively account for 57.9% of the variance in STD. These results align with emerging literature positioning circularity as a vital framework for reducing resource depletion and advancing multi-dimensional sustainability in tourism (Kaszás et al., 2026; Tomassini et al., 2025). However, disaggregating the CE construct revealed heterogeneous effects across individual dimensions. Four circular dimensions demonstrated significant positive statistical associations with STD:

Circular Product and Service Innovation (β = 0.552, t = 7.769, p < 0.001): Emerging as the primary predictor, innovation exerts the strongest relative influence on STD. This aligns with recent assertions that circular transition requires systemic redesign of service offerings rather than end-of-pipe waste management (Tomassini et al., 2025). Enterprises around SMNP that innovate business models embedding low-impact offerings, extended product lifecycles, and localized experiential design achieve superior sustainability outcomes.

Sustainable Procurement (β = 0.303, t = 4.555, p < 0.001): Sustainable procurement recorded the second-largest positive impact. In ecologically sensitive destinations like SMNP, integrating environmental criteria into purchasing strengthens local supply chains (e.g., sourcing local agriculture and handicrafts) while minimizing upstream ecological footprints. Reuse Practices (β = 0.261,t = 4.530,p < 0.001): Extending material and product lifecycles directly mitigates demand for virgin resources. By prioritizing reusability over single-use disposal, enterprises significantly reduce operational waste volumes. Resource Reduction and Efficiency (β = 0.102,t = 2.057,p = 0.041): Consistent with sustainability certification standards (Kaszás et al., 2026), minimizing water, energy, and material throughput yields accessible, cost-effective environmental gains.

In contrast to theoretical expectations, two dimensions yielded statistically significant negative regression coefficients: Renewable Energy and Resource Conservation ($\beta = -0.238, t = -3.228, p = 0.001$): Recycling and Waste Recovery ($\beta = -0.143, t = -2.152, p = 0.032$): Rather than suggesting that renewable energy or recycling inherently impair sustainability, these inverse parameter estimates reflect partial conditional relationships within a multivariate model. In developing tourism contexts like peripheral SMNP, high recycling or conservation activities often signal reactive measures to severe existing operational constraints (e.g., chronic waste accumulation, grid instability, or resource scarcity) rather than proactive, mature circular systems. Furthermore, capital expenditure, maintenance costs, and inadequate local recycling/energy infrastructure can impose short-term financial and operational burdens on small- and medium-sized hospitality enterprises, depressing perceived sustainability performance.

While circular practices explain over half of the variance (57.9%) in STD, 42.1% remains attributable to unobserved exogenous factors, such as destination governance, infrastructure maturity, institutional support, and community engagement. Crucially, these findings demonstrate that treating the circular economy as a monolithic construct masks critical operational dynamics. Methodologically, the cross-sectional design establishes statistical association rather than strict causality; future longitudinal research should investigate the contextual turning points at which initial implementation costs shift into net positive sustainability gains.

5. Conclusions and Recommendations

5.1 Conclusions

This study empirically evaluated the relationship between circular economy (CE) practices and Sustainable Tourism Development (STD) among tourism and hospitality enterprises in the vicinity of Simien Mountains National Park (SMNP), Ethiopia. The overall regression model demonstrated high explanatory power ($F(6,298) = 68.236$, $p < 0.001$, $R2 = 0.579$), establishing that the six circular economy dimensions jointly account for 57.9% of the variance in STD.

The empirical findings demonstrate that circular economy implementation cannot be treated as a uniform or monolithic concept. Disaggregating the construct reveals significant operational nuances and divergent effects across individual dimensions:

- Strategic Drivers of Sustainability: Circular Product and Service Innovation emerged as the primary positive predictor ($\beta = 0.552$, $p < 0.001$), followed by Sustainable Procurement ($\beta = 0.303, p < 0.001$), Reuse Practices ($\beta = 0.261, p < 0.001$), and Resource Reduction and Efficiency ($\beta = 0.102, p = 0.041$). Embedding circularity into core service design, supply chains, material life-extension, and resource efficiency yields direct, high-value sustainability returns.
- Contextual Bottlenecks: Conversely, Renewable Energy and Resource Conservation ($\beta = -0.238$, $p = 0.001$) and Recycling and Waste Recovery ($\beta = -0.143, p = 0.032$) yielded statistically significant negative coefficients. Rather than signaling an inherent defect in renewable technologies or recycling, these inverse associations reflect structural boundaries—including high initial capital expenditures, underdeveloped regional processing infrastructure, and reactive waste management—characteristic of peripheral destination settings.

Overall, strengthening circular practices provides a viable pathway toward sustainable tourism around protected natural heritage sites. However, maximizing these benefits requires moving beyond isolated operational tweaks toward systemic, context-sensitive circular business models.

5.2 Recommendations

Based on the empirical findings, targeted recommendations are offered for enterprise managers, park administrators, regional policymakers, and destination stakeholders.

- Prioritize Circular Product and Service Innovation: Hospitality operators should redesign core offerings around low-impact packages, modular accommodations, and reusable service items. Innovation should leverage local cultural and natural assets to create circular tourism experiences.
- Institutionalize Sustainable Procurement & Supply Chain Linkages: Purchasing decisions must incorporate social and environmental criteria by favoring durable, repairable, and locally sourced goods. Enterprises should build strong supply-chain partnerships with local agricultural producers, artisans, and community suppliers around SMNP.
- Expand Internal Reuse and Efficiency Protocols: Enterprise managers should institute systematic procedures to extend material life (e.g., equipment, furnishings, and containers) and monitor routine resource consumption (water, energy, food waste) to reduce operational costs and environmental pressure simultaneously.
- Establish Targeted Infrastructure for Waste and Renewable Energy: Regional authorities and local government must strengthen public recycling facilities, waste-segregation transport networks, and technical support. Rather than expanding basic recycling mandates, emphasis must be placed on improving recycling processing quality and market access.
- Provide Financial and Technical Mechanisms for Energy Transition: Government institutions and financial organizations should offer targeted subsidies, micro-financing, and feasibility assessments to mitigate high capital and maintenance costs that currently hinder small-scale renewable energy investments.
- Promote Multi-Stakeholder Governance and Community Integration: SMNP management and local tourism bureaus should establish collaborative governance platforms bringing together enterprises, park authorities, waste operators, and local communities. Public policy should incentivize community-based circular inputs to ensure environmental strategies enhance local livelihoods.

5.3 Directions for Future Research

While this study provides robust baseline evidence, some avenues remain for future inquiry: Geographical and Comparative Expansion: Given the focus on SMNP, future studies should conduct comparative assessments across diverse national parks, urban centers, and heritage destinations in Ethiopia and East Africa to test model generalizability. Exploration of Exogenous Factors: The remaining 42.1% of unexplained variance underscores the need to examine additional macro-level determinants, such as destination governance, regulatory enforcement, tourist environmental consciousness, and financial access. In-Depth Qualitative & Longitudinal Diagnostic: To better understand the negative associations observed for recycling and renewable energy, qualitative case studies and longitudinal designs should investigate contextual barriers (e.g., initial investment shocks, technical failures, infrastructure deficits) and track performance transformations over time. Impact Evaluation of Specific Interventions: Field experiments and cost-benefit evaluations should measure the precise ecological and financial paybacks of specific circular investments (e.g., grey water recycling, solar PV installation, local procurement quotas) over extended operational lifespan.

Declarations

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Clinical Trial Registration

Not applicable. This study was not a clinical trial.

Ethical approval and consent to participate

Ethical approval was obtained from the Research, Publication, and Ethics Review Committee at Debark University. The study adhered to the Research, Publication, and Ethics Guidelines of Debark University and the National Research Ethics Review Guidelines under the Ministry of Science and Technology of Ethiopia. Before data collection, all participants were informed about the study's purpose, their rights, and given informed consent for household surveys, interviews, focus group discussions, and questionnaires. Participation was voluntary. Privacy, confidentiality, and anonymity were strictly maintained.

Data Availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request, subject to applicable data-protection and confidentiality requirements.

Competing interests

The author declares no competing interests.

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Figures

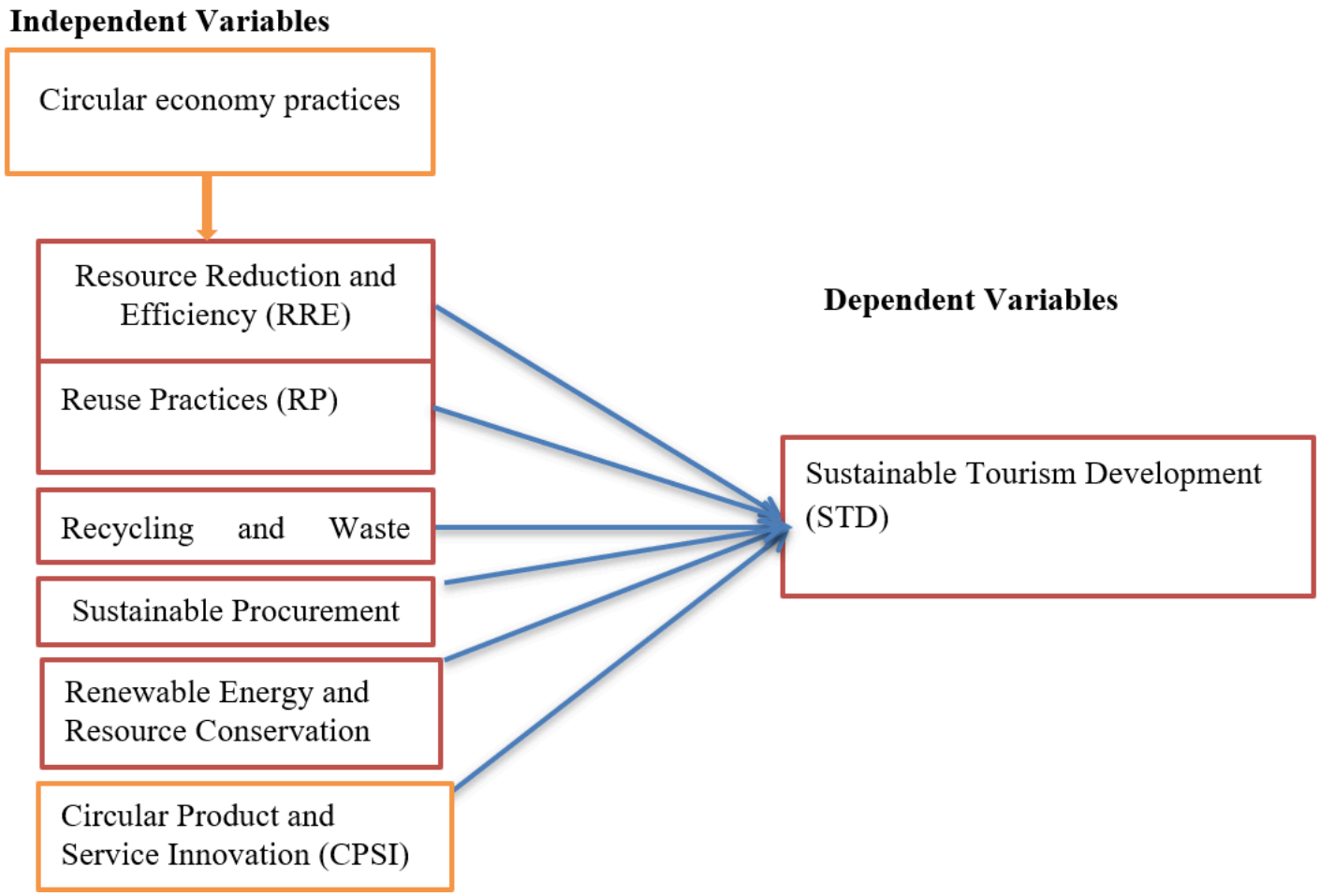


Figure 1

Figure 1.1: Conceptual Framework of Circular Economy Practices and Sustainable Tourism Development (Constructed by authors, 2026).