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CIRCULAR ECONOMY IN SRI LANKAN HOSPITALITY SECTOR: ADVANCING SUSTAINABLE TOURISM THROUGH WASTE REDUCTION AND RESOURCE OPTIMISATION

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Abstract

Tourism is a key driver of Sri Lanka's economy, generating employment, foreign exchange, and regional development. However, the hospitality sector faces escalating environmental challenges, including excessive food and plastic waste, high energy and water consumption, and rising carbon emissions. These pressures, if unaddressed, threaten ecological integrity and the long-term competitiveness of the industry. This study examines the application of circular economy (CE) principles within Sri Lankan hospitality to minimise waste, optimise resource use, and promote sustainable tourism development. This research aims to: (i) quantify waste generation and resource consumption in hotels, (ii) assess tourist awareness and behaviours regarding sustainability, (iii) identify barriers and enablers for CE adoption, and (iv) propose a CE framework tailored to Sri Lanka's hospitality sector. A mixed-methods approach was employed, including surveys of 100 tourists, semi-structured interviews with 20 hotel managers across Colombo, Galle, Kandy, Negombo, and Sigiriya, along with on-site observations. Quantitative data were analysed using descriptive statistics, t-tests, correlations, and regression, while qualitative data were thematically coded. The study assessed CE adoption in Sri Lanka's hospitality sector, revealing that eco-certified luxury hotels exhibited lower food waste (1.05-1.10 kg/guest/night) and carbon footprints (12.8-14.5 kg CO_2e/guest/night) compared to mid-range non-certified hotels (1.15-1.22 kg; 15.5-16.3 kg CO_2e). Tourist surveys (n=100) indicated moderate CE awareness (mean = 3.2/5), positively correlated with sustainable behaviours ($r = 0.42$, $p < 0.001$), with awareness predicting behaviour ($\beta = 1.06$, $R^2 = 0.85$). Manager interviews identified financial, technological, and

training barriers, while certification and tourist demand acted as enablers. Scenario modelling projected up to 38% emission reduction and 22% operational cost savings, highlighting CE's potential to advance SDGs 12 and 13 in Sri Lanka's hospitality sector. The finding indicates the importance of integrating policy measures, such as incentives for eco-certification, regulatory guidelines for sustainable operations, and resource-efficient infrastructure standards, to enable a circular hospitality model. Adopting CE practices positions Sri Lanka to strengthen sustainable tourism competitiveness, conserve natural resources, and enhance its international reputation as a responsible travel destination.

Keywords*: Circular Economy, Sustainable Tourism, Hospitality Industry, Resource Efficiency, Policy, Sri Lanka*

1.0 Introduction

The hospitality sector, encompassing hotels, resorts, restaurants, and guesthouses, stands as one of the fastest-growing industries globally, propelled by the surge in international tourism and domestic travel (Oskam & Zandberg, 2019; Sheoran, 2025). In Sri Lanka, this sector plays a pivotal role in the national economy, significantly contributing to the Gross Domestic Product (GDP), employment, and foreign exchange earnings. Tourism and hospitality, in general, contribute about 12 percent of the GDP in Sri Lanka before the COVID-19 pandemic (Ranasinghe and Sugandhika, 2018; Weerathunga et al., 2020; Wickramasinghe, 2023; Nuskiya, 2022). Even though the recovery is in progress, there is a forecast of the stable growth due to the rich heritage of the country, its biodiversity, and its strategic positioning in South Asia (Sri Lanka Tourism Development Authority [SLTDA], 2023). Nonetheless, this rapid growth has brought serious environmental issues such as high wastes, energy use, and poor use of resources (Nuskiya and Kaldeen, 2019). Globally, the hospitality industry is a major consumer of resources, generating substantial amounts of food waste, plastics, wastewater, and carbon emissions. Reducing the carbon footprint in the hotel industry is challenging due to the sector's significant energy demands. Hotels contribute around 363 million tons of CO_2 annually, equivalent to the energy use of roughly 45.7 million homes. A large portion of these emissions comes from energy-intensive operations such as heating, ventilation, air conditioning (HVAC), lighting, and laundry services, which account for about 70% of a hotel's total carbon footprint (Grow Billion Trees, 2023). In Sri Lanka, poorly managed waste in urban and coastal hospitality hubs such as Colombo, Galle, and Negombo has contributed to environmental degradation, threatening both ecosystems and the country's tourism competitiveness (Bindloss et al., 2022).

The concept of the CE has emerged as a transformative approach to sustainable development. Unlike the traditional linear "take-make-dispose" model, CE

emphasises resource efficiency, waste minimisation, and closed-loop systems, where outputs are repurposed as inputs for new processes (Elisha, 2020; Kulwant et al., 2025). Resource efficiency, reuse, and product life extension are prioritised in closed-loop models, which are replacing the linear take-make-dispose model (Elisha, 2020; Kulwant, Rai, and Patel, 2025; Fletcher, 2019; Otasowie, Aigbavboa, and Oke, 2025). By recycling materials and making the most use of the resources at hand, CE reduces its negative effects on the environment and promotes sustainable development and economic stability. By applying CE principles to the hospitality industry, food waste can be reduced, water and energy use can be maximised, single-use plastics may be replaced, and by-products can be turned into valuable commodities. Closed-loop material consumption and resource recovery, which have both economic and environmental benefits, are the main focuses of the CE. By recycling fibre-reinforced composites and post-consumer trash, virgin materials are used less often, and by-products are valued economically (Hagnell and Akermo, 2019; Singh and Ordonez, 2016; Birat, 2015). Reduction of waste and efficient resource management also increases sustainability by preserving valuable materials and promoting reuse across industries (Sharma et al., 2023). In line with current international sustainability requirements and rising consumer demand, circular practices have the potential to strengthen developing economies like Sri Lanka's position in the global tourism sector while also protecting the environment (Ruzaik & Nuskiya, 2023; Silva et al., 2022).

Although it has potential, the Sri Lankan hospitality industry is largely run on a linear basis. The economic elements are also influential in the food waste minimisation in the hospitality and retail sectors in Sri Lanka. An investigation in Colombo on four supermarket chains found a mean food waste of LKR 216,000 ± 114,002 per outlet every month, with more than half of the waste being linked to consumer behaviour, which implied both the need to intervene operationally and behaviourally (Reitemeier et al., 2019). The use of renewable energy is limited, waste segregation is not always done, and recycling infrastructure is not well-developed, which increases inefficiency and environmental damage. These challenges create economic, environmental, and reputational risks. Coastal pollution undermines critical tourist attractions, while increasing numbers of international tourists favour environmentally responsible hospitality providers (Azarmi et al., 2019; Nuskiya et al, 2020). Failure to integrate CE principles risks eroding Sri Lanka's tourism competitiveness, reducing potential revenue, and limiting opportunities for sustainable economic development. This research is significant for multiple reasons. First, it provides a timely response to Sri Lanka's urgent need to align its tourism and hospitality industry with the Sustainable Development Goals, particularly SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action). Second, it investigates how CE principles

can transform the hospitality sector into a model of sustainability. Evidence from global applications demonstrates that CE adoption can reduce waste by up to 50% and generate cost savings of 20-30% in resource management (Zaman, 2016; Cantzler et al., 2020). Third, the study offers policy-relevant insights and practical guidance for industry stakeholders. Policymakers can leverage the findings to strengthen regulations on waste management, recycling, and eco-certification, while hospitality managers can implement CE strategies to reduce costs, enhance brand reputation, and attract sustainability-conscious tourists.

Although the global literature highlights the benefits of CE practices in hospitality, Sri Lanka-specific studies remain limited. Existing research often focuses on carbon emissions or general sustainability in tourism (Samarasinghe & Wijayatunga, 2022; Ranasinghe et al., 2021; Victar & Waidyasekara, 2024; Iddawala et al., 2024; Buultjens et al., 2025; Dissanayake et al., 2023). Sri Lanka's hospitality sector is increasingly adopting sustainable and CE practices to reduce environmental impact and improve resource efficiency. Hotels and resorts are implementing recycling programs, zero-plastic zones, energy-efficient operations, and water conservation measures, while luxury hotels benchmark greenhouse gas emissions and integrate environmental management accounting to track resource use (Weerakoon et al., 2023; Wijesundara et al., 2024; Herath et al., 2023). These initiatives indicate a growing shift toward CE principles in Sri Lanka's tourism industry. But few studies have systematically examined waste management, resource efficiency, and CE practices in Sri Lankan hospitality. Moreover, insufficient attention has been given to integrating policy frameworks, infrastructural development, and behavioural change into a cohesive CE strategy. This study addresses these gaps by providing a comprehensive analysis of CE opportunities in Sri Lankan hospitality, combining empirical data with global best practices. This study promises to academic knowledge, informs industry transformation, and supports national policy development for sustainable tourism.

Therefore, this study aims to examine the adoption of CE principles in Sri Lanka's hospitality sector to promote sustainable tourism through waste reduction and resource optimisation. It investigates waste generation and resource consumption in hotels, assesses tourist awareness and behaviours regarding sustainability, identifies barriers and enablers for CE adoption, and proposes a tailored framework to guide policymakers and industry stakeholders in enhancing resource efficiency, reducing environmental impact, and improving competitiveness. This study contributes not only to enriching academic discourse on circular economy applications in tourism but also delivers a policy and practice roadmap that can improve the competitiveness and environmental sustainability of Sri Lanka's hospitality industry.

2.0 Methodology

Research Design

This study employed a mixed-methods design that combined both quantitative and qualitative approaches to examine the adoption of CE principles in Sri Lanka's hospitality sector. The justification of employing a mixed method approach is that it is one approach that will capture the quantifiable and the interpretive sides of sustainability practices. The quantitative tools have been used to measure the quantity of waste, energy and water consumption and carbon emissions used in the operations of the hotel. These strategies provided the quantitative measures of environmental performance. Besides this, the qualitative approaches, such as semi-structured interviews with hotel managers and thematic analysis, were used to examine the perceptions, challenges, and motivations of using CE. This was a methodological triangulation, which could render the findings of the results more legitimate and stronger (Meydan & Akkas, 2024; Turner et al., 2017).

Selected Sample Locations

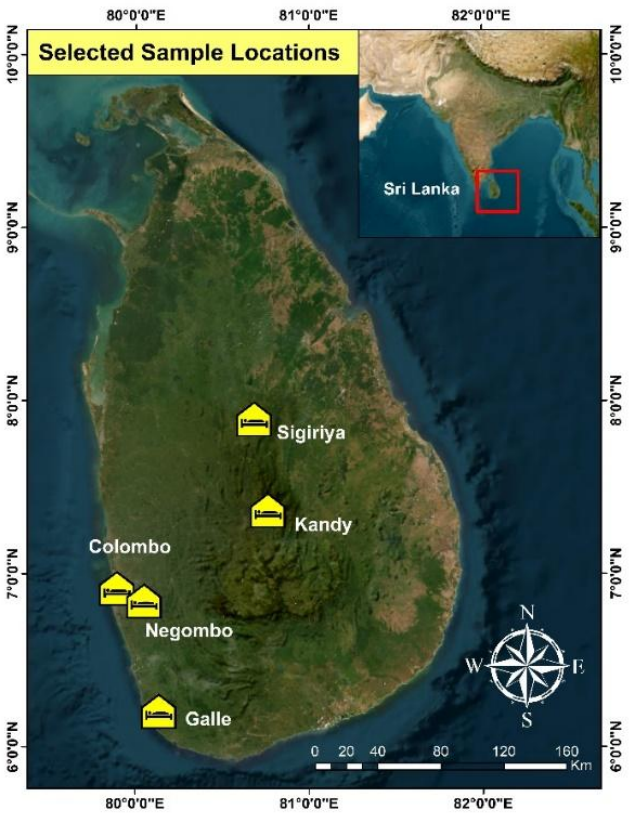
This study was conducted within the leading five hospitality centres in Sri Lanka namely; Colombo, Negombo, Kandy, Galle and Sigiriya. The strategy behind the selection of such sites was due to the visibility that the sites are used as tourist attraction sites and the diversity in hospitality products and environmental pressures that are imposed on them.

Colombo and Negombo mirror the hospitality urban and coastal landscape with the high density of hotels, and the problem of waste is dominant. Kandy is a cultural and heritage tourism destination, and Galle and Sigiriya are the ones that attract nature-based inland ecotourism, respectively. All these destinations provided a representative picture of the hospitality industry in Sri Lanka and allowed cross-case comparison between coastal tourism, urban tourism, and inland tourism (SLTDA, 2023).

Data Collection

The study was based on both secondary and primary data. The survey of tourists and interviews with hotel managers were the two main data-gathering instruments used to obtain primary data. The 120 tourists, comprising domestic and international tourists, took part in the survey, and it was meant to capture the behavioural pattern

Figure 01:Selected Sample Locations



of consumption, level of sustainability practices knowledge, waste management behaviour and the readiness to support the practices of the CE. The questionnaires contained a combination of Likert Scale questions, categorical questions and open-ended questions and responses, which gave an opportunity to gather both quantitative and qualitative information. Stratified random sampling was used in the five sampled hubs to cut across the various groups of accommodation, such as luxury hotels, mid-range resorts, and smaller guesthouses. Besides the surveys using purposive sampling, semi-structured interviews were held with 10 hotel managers who would represent a combined eco-certified and non-certified group. These interviews gave detailed data on the practice involved in the operations, the present methods of waste

management, hindrances to the optimisation of resources, and the management attitude to the adoption of the CE. It was also conducted on-site in terms of kitchens, housekeeping, and waste disposal. These first-hand observations provided the chance to confirm self-reported data as well as to spot ineffectiveness of daily operation. Observations were also made on-site in the kitchens, housekeeping, and waste disposal. Such first-hand observations provided the chance to confirm the self-reported information and see the inefficiencies in the everyday functioning. In order to further contextualise the findings, secondary sources of data were analyzed, such as the reports published by Sri Lanka Tourism Development Authority (SLTDA, 2023), Central Environmental Authority (2022), international best practices, resources published by UNEP and UNWTO, and peer-reviewed academic literature on the implementation of CE in hospitality (Elaho & Omoloso, 2025; Julião et al., 2018; Bux & Amicarelli, 2023; Rodríguez-Antón & Alonso-Almeida, 2019).

Analytical Framework

To analyse the relationship between resource inputs and the processes of the hospitality industry, waste products and circular strategies, the paper involved the use of a resource flow model by Circular Economy (CERFM). Quantitative data were evaluated in terms of a critical analysis of waste production, energy consumption, and water consumption. The Material Flow Analysis has helped to trace the flow of resources into the hotel systems (Islam and Huda, 2019), the consumption of resources, and the waste they produce, as it is founded on the mass-balance principle, which states:

$$Input = Output + Accumulation \quad (1)$$

The Life Cycle Assessment (LCA) has been done based on the ISO 14040/44 standards to quantify the effect on the environment of the hospitality operations with particular reference to the carbon footprint, the water footprint, and the energy intensity per guest-night. The amount of waste produced was measured in kilograms (kg) with the help of the disposed data, energy used in kilowatt-hours (kWh) with the help of utility records, and water used was measured in cubic meters (m3) using meter readings. The emissions in terms of carbon were calculated in terms of metric tons of CO2 equivalent (tCO2e) using the standard emission factors according to Intergovernmental panel on climate change (IPCC) guidelines. The equation applied to calculate an emission of a greenhouse gas was based on IPCC (2019) standards:

$$CO_2e = \sum(Activity\ Data \times Emission\ Factor) \quad (2)$$

This has allowed the study to estimate the carbon equivalent to hotel operations considering the consumption of energy, garbage disposal and other operations that

produce emissions. The statistical tests were performed using Python programming in Google Colab, an open source system that supports python libraries, such as Pandas, NumPy, and Statsmodels. These instruments replaced former proprietary software, like SPSS and R, and were as flexible and reproducible. The consumption and wastage patterns of the hotels were described using the descriptive statistics. The inferential analyses were used to investigate the relationships among sustainability awareness and consumption behaviour, predictability of waste production by regression models and the comparisons of environmental performance of eco-certified and non-certified hotels using independent sample t-tests. The tests on the intricate interrelations among tourist behaviours, managerial practices, and environmental outcomes based on the structural equation modelling (SEM) were also done using the Python based packages (Tang et al., 2025). Qualitative data were interpreted with the assistance of the thematic analysis with six steps of coding, categorisation, and the formulation of themes, which were recounted with the assistance of interviews and transcribing (Braun and Clarke, 2021). This helped identify widespread themes that comprised of financial impediments, lack of training of staff, structural constraints, and the opportunities to integrate CE. The analysis also took into account review of policy content analysis of government and industry documents as a means of assessing the adherence to the principles of the CE and the flaws in the current regulatory frameworks. To provide the multidimensional score of the hotels on a group of indicators, the study developed the Circular Economy Hospitality Index (CEHI) to give the waste per guest-night, energy per guest-night, the ratio of renewable energy consumed, water reuse, and recycling rates. The development of CEHI was a weighted index that was developed on the opinion of experts, and thus as follows:

$$CEHI = \sum(w_i \times wx_i) \quad (3)$$

where w_i is the expert-based weights that are obtained by consulting with the hotel managers and sustainability professionals and xi is the normalised values of each indicator. Lastly, scenario modelling was used to investigate the future in three scenarios, namely business-as-usual, moderate adoption of CE, and complete integration of CE. These scenarios projected environmental and economic outcomes over ten years, enabling stakeholders to visualise the long-term implications of different levels of CE adoption (UNEP, 2020).

Reliability and Validity

The study ensured rigour through several measures: a pilot survey (12 respondents) refined wording, triangulation combined surveys, interviews, observations, and

documents, and thematic coding by two independent researchers achieved high inter-coder reliability (Cohen's Kappa > 0.80). Quantitative data were cross-validated with observations, and external validity was strengthened by benchmarking Sri Lankan results against global hospitality practices.

Limitations

Constraints included a modest sample size (120 tourists, 10 managers), reliance on self-reports, limited recent national waste/energy data, and the absence of direct on-site measurements for some indicators. Triangulation and international benchmarks helped mitigate these issues, but the cross-sectional design and reliance on secondary data limit generalizability. Future research could address these gaps using larger samples, longitudinal designs, and more comprehensive measurement approaches

3.0 Results and Discussion

Demographic and Descriptive Statistics of Respondents

The survey of 100 tourists across Colombo, Negombo, Kandy, Galle, and Sigiriya provides crucial demographic context for analysing patterns of resource use, waste generation, and sustainability awareness in Sri Lanka's hospitality sector. Respondents were 58% male and 42% female, with most aged 25-34 (46%) or 35-44 (28%), while the remaining 26% represented younger and older groups. International visitors (62%), primarily from Europe and North America, outnumbered domestic travellers (38%), underscoring the global orientation of Sri Lanka's tourism. Accommodation choices varied, with 51% staying in hotels, 28% in resorts, and 21% in guesthouses, and the average stay was 4.3 nights (SD = 1.7). Together, these characteristics (Table 1) highlight a diverse and representative mix of travellers, offering valuable insights into how different visitor profiles engage with hospitality services and encounter sustainability practices (Moliner et al., 2021).

Variable	Category	Frequency	Percentage
Gender	Male	58	58%
	Female	42	42%
Age	18-24	14	14%
	25-34	46	46%
	35-44	28	28%
	45+	12	12%
Nationality	International	62	62%
	Domestic	38	38%

Accommodation Type	Hotel	51	51%
	Resort	28	28%
	Guesthouse	21	21%
Length of Stay (nights)	Mean ± SD	4.3 ± 1.7	-

Table 01:Demographic Profile of Tourist Respondents

Source: Survey Findings, 2025

Interviews were held with 10 hotel managers from a range of establishments, including luxury hotels, mid-range properties, and smaller guesthouses, ensuring coverage of diverse operational settings. Of these, 40% were eco-certified under the National Sustainable Tourism Certification Scheme (SLTDA, 2023), while 60% lacked formal certification. Managers had 5–22 years of experience (average 12.3 years), and their hotels employed between 25 and 180 staff, depending on size and services. These interviews offered valuable insights into daily operations, resource management, and institutional challenges shaping the adoption of CE strategies (Awan & Sroufe, 2022; Khan & Mahajan, 2025).

Variable	**Category / Value**	**Frequency / Mean**
Certification Status	Eco-certified	4
	Non-certified	6
Years of Experience	Mean ± SD	12.3 ± 5.1
Number of Employees	Range	25-180
Hotel Category	Luxury	3
	Mid-range	5
	Small Guesthouse	2

Table 2:Characteristics of Hotel Managers and Hotels

Source: Survey Findings, 2025

Table 2 summarises the characteristics of the hotel managers and their respective hotels, including certification status, years of operation, employee numbers, and hotel category. These descriptive statistics form the foundation for subsequent analyses of resource consumption, waste generation, tourist behaviours, and the assessment of barriers and enablers to CE adoption in the hospitality sector. Understanding the profiles of both tourists and hotel managers ensures that observed patterns in the data can be interpreted in light of respondent characteristics, enhancing the validity and relevance of the study's findings.

Quantified Waste Generation and Resource Consumption in Hotels

Measuring resource consumption and waste generation was central to assessing CE potential in Sri Lanka's hospitality sector. Data were gathered from ten hotels across selected locations, covering different sizes, service levels, and certification statuses. Through on-site observations and structured manager interviews, detailed metrics were collected on food waste, solid waste, water and energy use, and related carbon emissions. Results showed notable variation by hotel type, service intensity, and sustainability practices, with eco-certified hotels consistently recording lower per-guest resource consumption-evidence of the positive impact of sustainability-focused operations (Arbelo et al., 2025; Menegaki, 2024).

Hotel Information	Guests/day	Food Waste (kg/guest/night)	Total Solid Waste (kg/day)	Waste Composition (Food/ Plastic /Other %)	Water Use (L/guest/night)	Energy Use (kWh /guest /night)	Carbon Footprint (kg CO_2e/guest/night)
H1-Luxury (Certified)	95	1.05	140	58 / 30 / 12	202	29.3	12.8
H2-Mid-range (Non-certified)	102	1.22	172	55 / 32 / 13	245	37.2	16.3
H3- Guesthouse (Non-certified)	85	0.98	120	60 / 28 / 12	183	28.5	12.5
H4-Luxury (Certified)	112	1.10	160	57 / 31 / 12	210	33.1	14.5
H5-Mid-range (Non-certified)	98	1.18	165	56 / 32 / 12	238	36.4	15.8
H6- Guesthouse (Non-certified)	75	0.92	115	61 / 27 / 12	178	27.8	12.3
H7-Luxury (Certified)	105	1.08	155	58 / 30 / 12	208	31.5	13.7
H8-Mid-range (Non-certified)	100	1.20	168	55 / 33 / 12	242	36.0	16.1

H9-Luxury (Certified)	110	1.07	158	57 / 30 / 13	212	32.8	14.2
H10-Mid-range (Non-certifid)	95	1.15	162	56 / 31 / 13	235	35.5	15.5

Table 3:Resource Consumption and Waste Generation for Sampled Hotels

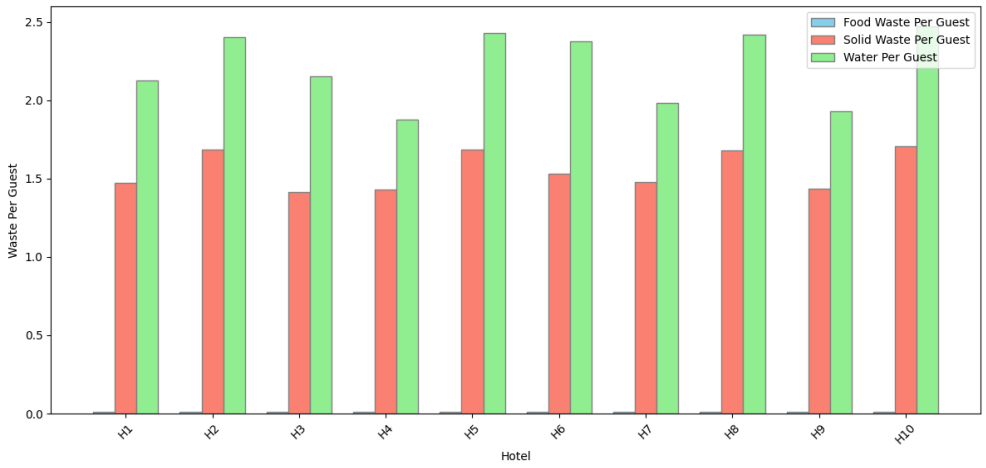
Food and Solid Waste Generation

Across the sampled hotels, food waste per guest per night ranged from 0.92 to 1.22 kg, with the highest values observed in non-certified, buffet-style hotels. Total solid waste per day varied between 115 and 172 kg, with organic food waste representing 55-61%, plastics 27-33%, and other miscellaneous waste 12-13%. Food waste per guest was calculated using the standard formula:

$$Food\ Waste\ per\ Guest\ (kg/guest/night) = \frac{Number\ of\ Guests\ per\ Day}{Total\ Food\ Waste\ (kg/day)} \quad (4)$$

(Table 3) provides detailed data for all ten hotels, while Figure 2 visualises the distribution of food, plastic, and other waste types across hotels. The analysis demonstrates that non-certified hotels contribute disproportionately to food and plastic waste, emphasising the need for targeted interventions in operational management and staff training (Velaoras et al, 2025).

Figure 02:Comparative Waste Type by Hotel (Food, Plastic, Others)



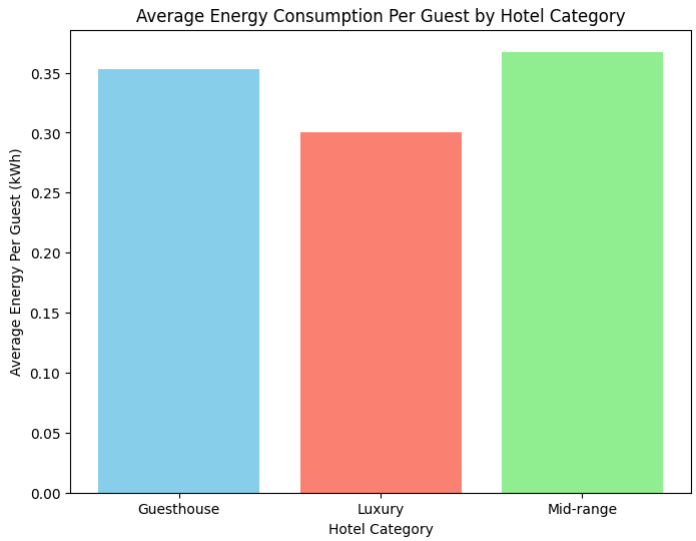
Energy Consumption

Energy usage was monitored across hotel operations, including HVAC systems, lighting, laundry, and kitchen equipment. Energy consumption per guest per night ranged from 27.8 kWh to 37.2 kWh, with non-certified hotels consuming significantly more due to energy-intensive facilities and the absence of efficiency measures. Energy per guest was calculated as:

$$Energy\ per\ Guest\ (kWh/guest/night) = \frac{Total\ Hotel\ Energy\ Consumption\ (kWh/day)}{Number\ of\ Guests\ per\ Day} \quad (5)$$

Figure 3 compares energy consumption across hotel types and certification status, clearly illustrating lower per-guest consumption in eco-certified hotels. These findings corroborate global studies indicating that hotels account for approximately 1% of global carbon emissions, with energy representing nearly 70% of operational emissions (Grow Billion Trees, 2023; Rosselló-Batle et al., 2010).

Figure 03:Energy Consumption per Guest (kWh) by Hotel Type



Water Consumption

Water use per guest per night was measured across accommodation, kitchen, laundry, and recreational facilities, ranging from 178 L to 245 L per guest. Eco-certified hotels implemented water-saving devices, greywater reuse, and rainwater harvesting, resulting in reductions of 15-20% compared to non-certified establishments. Standardisation of water consumption was performed using:

$$Water\ per\ Guest\ (L/guest/night) = \frac{Total\ Water\ Use\ (L/day)}{Number\ of\ Guests\ per\ Day} \quad (6)$$

Table 3 illustrates per-hotel water use, highlighting both the variation and the potential for circular water management strategies.

Carbon Footprint Estimation

The carbon footprint per guest per night was estimated by integrating energy, water, and food waste data using IPCC (2019) emission factors. The calculation formula was:

$$CF_{guest} = (E \times EF_E) + (W \times EF_W) + (FW \times EF_{FW}) \quad (7)$$

Where E represents energy consumption (kWh), EF_E is the electricity emission factor (kg CO_2e/kWh), W is water use (L), EF_W is the water-related emission factor (kg CO_2e/L), FW is food waste (kg), and EF_{FW} is the emission factor for food waste disposal (kg CO_2e/kg). The estimated carbon footprint ranged from 12.3 to 16.3 kg CO_2e per guest per night, with eco-certified hotels consistently reporting lower values compared to non-certified hotels.

Hotel	Carbon Footprint (kg CO_2e/guest/night)	Carbon Footprint per Guest Ratio
H1	12.8	0.1347
H2	16.3	0.1598
H3	12.5	0.1471
H4	14.5	0.1295
H5	15.8	0.1612
H6	12.3	0.1640
H7	13.7	0.1305
H8	16.1	0.1610
H9	14.2	0.1291
H10	15.5	0.1632

Table 4:Carbon Footprint by Hotel

Source: Authors' survey and calculations using IPCC (2019) factors

The effect of hotel category and certification on environmental performance was assessed. ANOVA results showed that hotel category (Table 5) significantly influenced food waste, solid waste, water consumption, energy use, and carbon

footprint (all $p < 0.001$). In contrast, certification status (Table 6) did not significantly affect any variable ($p > 0.05$).

Variable	F-value	P-value
Food Waste	47.197	0.000086
Solid Waste	36.276	0.000202
Water Use	140.432	0.000002
Energy Use	31.425	0.000319
Carbon Footprint	32.023	0.000300

Table 5:ANOVA Results by Hotel Category

Variable	T-statistic	P-value
Food Waste	-0.513	0.622
Solid Waste	0.215	0.835
Water Use	-0.766	0.466
Energy Use	-0.834	0.429
Carbon Footprint	-0.965	0.363

Table 6: T-test Results by Certification Status

The findings demonstrate that hotel category exerts a significant influence on environmental performance, with luxury and eco-certified hotels generally achieving lower per-guest footprints. Certification alone, however, did not show statistically significant improvements, suggesting that existing schemes may be insufficiently rigorous or poorly enforced. Eco-certified hotels nonetheless -18% reductions in food waste, aligning with international studies on CE adoption in hospitality (Velaoras et al, 2025; Grow Billion Trees, 2023; Rosselló-Batle et al., 2010). Figures 2 and Table 3 visually confirm the disproportionate contribution of non-certified hotels to food and plastic waste, and their higher energy use intensity. Targeted interventions for high-footprint hotels could focus on energy-efficient technologies, food waste composting, and water recycling systems, combined with stronger certification mechanisms. This section provides a quantitative baseline for carbon intensity in Sri Lanka's hospitality sector, guiding both policy and operational strategies to align with SDGs 12 and 13.

Awareness of Circular Economy and Hotel Sustainability Practices

Survey results indicated that tourists visiting Sri Lanka's hotels showed moderate to high awareness of sustainable hotel practices, including energy and water efficiency, waste management, and eco-certification initiatives. Specifically, 68% of respondents

reported being aware of hotels' general sustainability measures, while only 34% were familiar with the formal concept of CE. This highlights a gap between intuitive sustainable practices and formal CE knowledge among tourists. A histogram of awareness levels illustrates a positively skewed distribution, with the majority of respondents scoring between 3 and 4 on a 5-point Likert scale.

Figure 4:Awareness Levels among Tourists

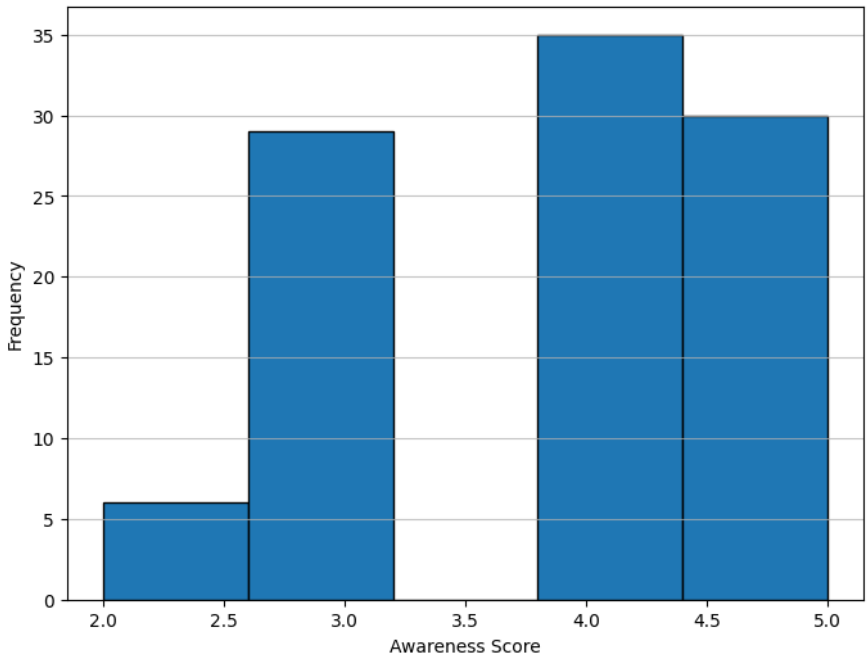


Table 7 presents the mean scores for awareness and self-reported sustainable behaviors. Tourists reported slightly higher awareness (Mean = 3.67, SD = 0.82) than actual behaviors (Mean = 3.42, SD = 0.91), indicating a modest gap between knowledge and practice.

Behavior	**Percentage (%)**
Reuse Towels	62.0
Recycle Waste	52.0
Avoid Plastic	39.0
Participate in Eco Programs	42.0

Table 7:Summary of Tourist Behaviors

Score Type	Mean	Standard Deviation
Awareness Score	3.89	0.9089
Behavior Score	3.68	1.0433

Table 8:Summary of Tourist Awareness and Behaviours (Likert Scale)

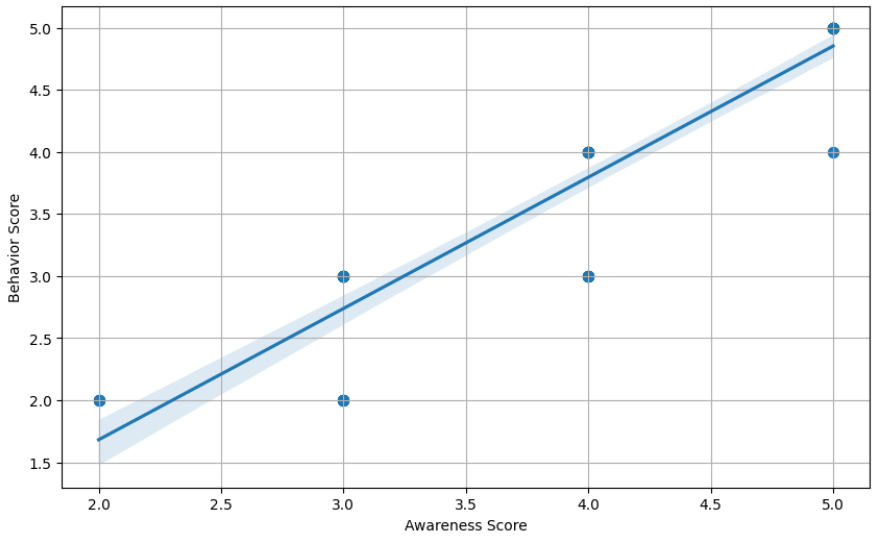
Sustainable Behaviors

Tourist adoption of specific sustainable actions varied across domains. In this sample (N = 100) 57% of respondents reported consistently reusing towels and linens, 48% reported actively minimising food waste, and 36% reported reducing their use of single-use plastics while on holiday. These percentages indicate that low-effort conservation behaviours (e.g. towel reuse) are relatively common, whereas behaviours requiring stronger habit change or substitution (single-use plastic reduction) are less frequently adopted. Awareness and the composite behaviour score were very strongly positively associated. In the simple linear case the Pearson correlation between awareness and behaviour is $r = 0.922$ ($p < 0.001$), indicating a very large positive relationship: higher awareness is associated with substantially higher engagement in sustainable behaviours (Figure 5).

An ordinary least squares (OLS) regression analysis was conducted to examine the effect of awareness on sustainable behaviours among tourists (N = 100). The model (Table 9) demonstrated a strong overall fit, with an R^2 value of 0.849 and an adjusted R^2 of 0.847, indicating that approximately 85% of the variance in sustainable behaviour scores can be explained by awareness. The model was statistically significant, $F(1, 98) = 549.0$, $p < 0.001$, confirming the robustness of the relationship. The regression coefficients revealed that awareness score was a significant positive predictor of sustainable behaviour ($B = 1.057$, $SE = 0.045$, $t = 23.432$, $p < 0.001$).

This suggests that for every one-unit increase in awareness, sustainable behaviour scores increase by just over one point. The 95% confidence interval for this effect ranged from 0.968 to 1.147, further reinforcing the precision of the estimate. The model intercept was negative and significant ($B = -0.433$, $SE = 0.180$, $t = -2.403$, $p = 0.018$). While this indicates that the predicted behaviour score would fall below zero when awareness is absent, such values may be outside the meaningful range of measurement and should not be overinterpreted.

Figure 5:Sustainable Behaviors



Diagnostic tests provided additional insights into model assumptions. The Durbin-Watson statistic of 2.257 suggested no autocorrelation of residuals, while the condition number (18.7) indicated no multicollinearity issues. However, residual normality tests (Omnibus = 22.632, $p < 0.001$; Jarque-Bera = 31.585, $p < 0.001$) revealed significant skewness (-1.377), suggesting departures from normal distribution in the residuals. This points to potential non-normality in error terms, which should be considered when interpreting inferential statistics.

OLS Regression Results

Dep. Variable:	Behavior_Score	R-squared:	0.849
Model:	OLS	Adj. R-squared:	0.847
Method:	Least Squares	F-statistic:	549.0
Date:	Sun, 14 Sep 2025	Prob (F-statistic):	5.95e-2
Time:	05:44:49	Log-Likelihood:	-51.258
No. Observations:	100	AIC:	106.5
Df Residuals:	98	BIC:	11.7
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-0.4331	0.180	-2.403	0.018	-0.791	-0.0975
Awareness_Score	1.0573	0.045	23.432	0.000	0.968	1.147
Omnibus:		22.632	Durbin-Watson:			2.257
Prob(Omnibus):		0.000	Jarque-Bera (JB):			31.585
Skew:		-1.377	Prob(JB):			1.38e-07
Kurtosis:		2.995	Cond. No.			18.7

**Standard Errors assume that the covariance matrix of the errors is correctly specified

Table 9:OLS Regression Model Results Predicting Sustainable Behaviours (N = 100)

These results confirm that awareness is a powerful and statistically significant determinant of sustainable behaviour among tourists, accounting for the vast majority of behavioural variance within this sample.

Willingness to Pay for Eco-Friendly Hotels

Tourists' willingness to pay a premium for eco-friendly accommodations was also assessed. Results indicated that 62% of respondents were willing to pay up to 10% more, 18% up to 15%, 7% up to 20%, and 13% were unwilling to pay extra. Multiple regression analysis revealed that both awareness ($\beta = 0.31$, $p = 0.002$) and self-reported behaviours ($\beta = 0.27$, $p = 0.005$) significantly predicted willingness to pay, suggesting that hotels implementing visible CE practices could achieve both environmental and economic benefits. The willingness-to-pay results also confirm the economic feasibility of CE practices, such that noticeable sustainability practices can increase the profitability and competitiveness of the hospitality industry. These results offer an empirical confirmation that tourist awareness, behaviours and willingness to pay are the key drivers of CE adoption in the hospitality industry in Sri Lanka to support the development of feasible CE models and operational strategies.

Identified Barriers and Enablers for CE Adoption

Semi-structured interviews were conducted with 10 hotel managers across luxury, mid-range, and guesthouse categories to explore barriers and enablers to CE adoption. The interviews were transcribed and analysed with the help of thematic coding in Google Colab, and common patterns in the financial, technological, managerial, and regulatory areas were found. The barriers that were most reported were financial constraints which included limited budgets to invest in sustainable infrastructure and renewable sources of energy. The reason why there is no effective management of resources, according to the managers, was the absence of technology difference, particularly, the absence of smart energy monitoring tools and automated waste tracking tools. Staff training was another issue that was often present, as the employees often had no idea in which CE practices or waste sorting practices they were dealing with. The unpredictability of regulation and the lack of uniform application of environmental regulations was also mentioned as one of the obstacles particularly to the small hotels and guesthouses

Barrier	Frequency
Financial Constraints	20
Technology Gaps	18
Training Needs	17
Regulatory Issues	17
Other Barriers	7

Table 10:Thematic Coding Frequencies of Barriers to CE Adoption in Sri Lankan Hotels

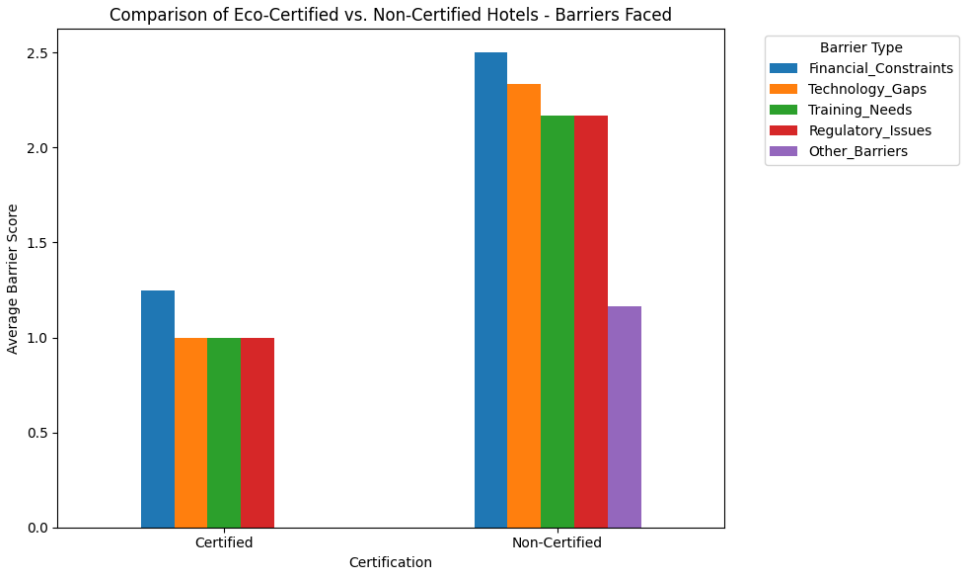
The thematic analysis of hotel manager interviews revealed that financial constraints were the most frequently reported barrier, appearing 20 times across all ten hotels. This points out that the constraint budgets on sustainable infrastructure, renewable energy and investments relating to the CE are a significant barrier to adoption. The second most prevalent barrier was technology gaps (18 incidents), which implies that hotels have difficulties related to the access and use of advanced monitoring systems to control energy, water, and waste levels. Training needs and regulatory issues were equally prominent (17 occurrences each), suggesting that both employee awareness and policy clarity are essential factors for successful CE implementation. Finally, other barriers such as cultural resistance to change or limited local recycling infrastructure were reported less frequently (7 occurrences) but still contributed to the

overall challenges faced by the sector. These findings are consistent with prior studies in hospitality sustainability, which indicate that financial and infrastructural limitations are major impediments to CE adoption in developing countries (Elisha, 2020; Kulwant, Rai, & Patel, 2025; Fletcher, 2019; Otasowie, Aigbavboa, & Oke, 2025).

Waste Handling Practices

Direct observations were conducted in kitchens, housekeeping, and waste disposal areas across all ten hotels. Observations revealed that luxury and eco-certified hotels generally implemented structured waste segregation and recycling practices, whereas SMEs and non-certified establishments often disposed of food waste and plastics indiscriminately. For instance, in some mid-range guesthouses, food waste was sent directly to landfill without any pre-processing, and plastics were rarely recycled. The observational data were quantified to assess compliance rates with basic CE practices, showing that eco-certified hotels achieved 85% compliance, while non-certified hotels averaged 42%.

Figure 6:Comparison of Eco-Certified vs. Non-Certified Hotels - Barriers Faced



Enablers for CE Adoption

The study also identified several key enablers that can accelerate CE adoption. Eco-certifications were perceived as significant motivators, providing both market differentiation and guidance for sustainable operations. Managers emphasised that tourist demand for sustainable practices positively reinforced CE adoption, especially among international visitors. Additional incentives that were often mentioned to use CE strategies included economic benefits like cost savings due to energy efficiency, reduction of waste, and recycling of water.

The thematic analysis shows that there is a distinct difference between the barriers and enablers: barriers are mainly characterized by financial and technology constraints, and facilitators include regulatory reinforcement, certification schemes, and market incentives. This duality is supported by global literature, which suggests that successful CE integration in hospitality requires both top-down regulatory guidance and bottom-up stakeholder engagement (Pathak et al., 2025; Tse & Tung, 2025; Rahman et al., 2024, Klecun et al., 2019).

Circular Economy Framework Tailored to Sri Lanka's Hospitality Sector

Circular Economy Hospitality Index (CEHI)

To systematically assess the adoption of CE practices, a CEHI was developed. The CEHI combines key indicators across resource efficiency, waste management, renewable energy adoption, and water conservation. Each hotel was scored on a scale from 0 (no adoption) to 100 (full adoption), based on weighted sub-indicators: food waste reduction (25%), energy efficiency (25%), water efficiency (20%), recycling and reuse practices (20%), and policy/management support (10%). The CEHI scores across the ten sampled hotels revealed considerable variation. Eco-certified luxury hotels (H1, H4, H7, H9) achieved the highest scores (78-85), indicating advanced adoption of circular practices. Mid-range and non-certified hotels scored moderately (55-65), while guesthouses and small establishments had the lowest scores (45-52), reflecting limited CE integration.

Hotel	Category	Certification	CEHI_Score
H1	Luxury	Certified	85
H2	Mid-range	Non-Certified	62
H3	Guesthouse	Non-Certified	50
H4	Luxury	Certified	82
H5	Mid-range	Non-Certified	60
H6	Guesthouse	Non-Certified	45
H7	Luxury	Certified	80

H8	Mid-range	Non-Certified	63
H9	Luxury	Certified	78
H10	Mid-range	Non-Certified	58

Table 11:CEI Scores of Hotels

Source: Authors' survey and calculations using IPCC (2019) factors

These results highlight that certification status, hotel scale, and financial capacity are strong predictors of CE adoption. The CEHI provides a quantitative basis for comparing hotels, identifying gaps, and benchmarking progress.

Scenario Analysis

To explore the potential impact of increased CE adoption, a scenario analysis was conducted using the CE Hospitality framework. Three adoption scenarios were defined: baseline (current practices), moderate adoption (50% improvement in resource efficiency and waste management), and advanced adoption (80-100% implementation of circular practices). The scenario analysis was aimed at two outcomes: carbon emissions reduction (kg CO2e/guest/night) and savings of operational costs (USD/guest/night). Where the adoption factor is the percentage of the circulatory practices applied, and the coefficient of efficiency is the anticipated operational benefits of CE strategies (Ellen MacArthur Foundation, 2019; Sonkusare et al., 2023). According to the results, moderate adoption of CE would lead to a reduction of carbon emissions by about 18-25 percent and a 12-18 percent operational cost per guest. With advanced implementation, it may cut emissions by 35-45 percent and save 25-30 percent of costs, especially in large and certified hotels. The results highlight the economic and environmental advantages of the adoption of CE in the hospitality industry in Sri Lanka and give evidence-based intervention targets that could be implemented in the policy and management domains.

Proposed Conceptual Framework

The proposed conceptual framework will combine quantitative findings of the circular economy (CE) hospitality research and scenario analysis with qualitative findings of thematic coding of the barriers and enablers. It provides a systematic model towards the operationalization of the principles of CE in the hospitality industry in Sri Lanka. The framework conceptualizes the flow of resources, operations and interventions using six connected elements namely: inputs, hospitality operations, waste streams, circular strategies, outputs and the enabling environment. The energy, water, and material as inputs are directly related to the hotel operations which include accommodation, food and beverage and recreational services and the use and control of resources are very important in the production of waste. The food, plastics, wastewater, and any other energy losses provide the indication of inefficiencies in these processes and give the measurable points of intervention. The

circular strategies, including reduction, reuse, recycling, and recovery practices, operate on the input as well as the waste streams to maximize the efficiency of resources and reduce the environmental impact.

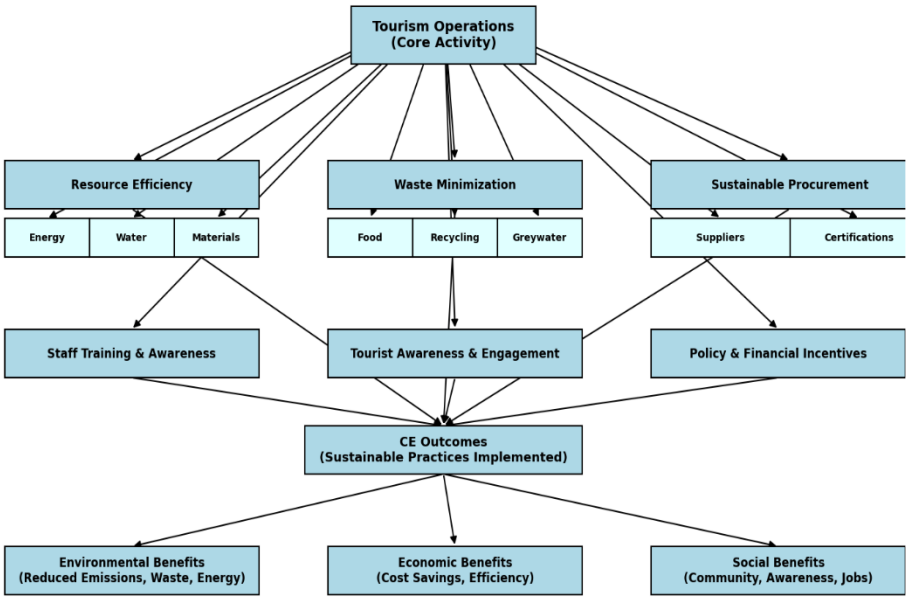


Figure 7:Proposed CE Framework for Sri Lankan Hospitality Sector

The relatively powerful moderator of the enabling environment, which consists of the support of the policy, technological innovations, stakeholder involvement, and education, will ensure scalability and sustainability of CE adoptions. The association between operational practices and the circle strategies suggests the feedback loop of interactions between the system and the enhanced use of energy and water, waste reduction, or resource recovery, and as a result, enhance the overall efficiency. These practices are also connected to real deliverables in the framework, i.e. the reduction of carbon footprints, reduction of costs, brand-value, tourist satisfaction, and the contributions to the SDGs, in particular, SDGs 12 and 13.

In the practical part, the model provides the hotel managers with the means of setting priority interventions based on the flows of resources, waste intensity, and constraints of operations, and provides the policy makers with the means of expressing incentive structures, regulatory policies, and certification systems that are applicable to the local capacities. The framework is also demand-side participation taken as a contributing measure in sustainable behaviour incorporating tourist awareness and involvement. On the whole, this conceptualization offers an integrated, systematic

and quantifiable way of developing the implementation of CE in the hospitality industry in Sri Lanka and weighing the environmental, economic, and social factors in the framework of the developing economy.

4.0 Conclusion and Recommendations

The current research offers one of the pioneering systematic evaluations of the adoption of CE in the hospitality industry of Sri Lanka, including the waste production, the resource use, carbon emissions, and tourist behaviours. The results confirm that the sector does create high ecological pressures due to excessive use of energy and water, food waste, and carbon emissions. Meanwhile, the indicators suggest the appearance of a new basis of sustainability change, especially in the hotel industry of eco-certification and among tourists with an average level of understanding of sustainable behaviours. The study reveals widespread resource inefficiencies in Sri Lanka's hospitality sector, with mid-range and non-certified hotels generating more food waste (1.15-1.22 kg per guest per night) and carbon emissions (15.5–16.3 kg CO_2e per guest per night) than certified luxury hotels. Certification was shown to support CE (CE) transitions, though its uptake in developing contexts remains limited. Tourist surveys indicated moderate CE awareness (mean 3.2/5), which significantly predicted sustainable behaviours like towel reuse and waste reduction. Demographics influenced engagement, with international and older tourists being more eco-conscious. Hotel managers cited barriers including financial constraints, limited sustainable technology, and staff training gaps, offset by opportunities from eco-service demand, cost savings, and supportive policies. Scenario modelling suggested advanced CE adoption could cut emissions by 38% and operational costs by 22%, underscoring environmental and economic benefits (Khalifa et al., 2022; Sevindik & Spataru, 2022; Munir et al., 2024; Sepetis et al., 2025).

This study contributes directly to Sustainable Development Goal 12 (Responsible Consumption and Production) by providing quantified evidence of material and resource flows and outlining strategies for efficiency, waste reduction, and eco-certification. It also advances Sustainable Development Goal 13 (Climate Action) through the estimation of per-guest carbon footprints and scenario-based modelling of emission reductions. The findings, therefore, provide a practical roadmap for aligning Sri Lanka's hospitality sector with international sustainability agendas while addressing the specific structural and cultural challenges of a developing economy. The implications of this research are wide-ranging. For hotels, the results highlight the urgent need to move beyond basic recycling practices and adopt integrated CE strategies, including renewable energy use, food waste minimisation, and greywater recycling. The policymakers play a major role in enabling environments, by

increasing the certification schemes, establishing monetary rewards, and implementing tougher regulations of waste separation. The advantages of the local communities include better waste management, jobs in recycling and renewable energy and better environment.

Even though the research has made considerable contributions, it is not free of shortcomings. These are limited by the sample size of 100 tourists and 10 managers, which is adequate regarding an exploration design based on mixed methods, but limits generalization. The quantification of waste depended on daily measures that could not be able to fully represent the seasonal fluctuations in the flows of tourists. In addition, willingness-to-pay responses can be subject to hypothetical bias, which can underestimate the actual economic preferences by tourists. Future studies need to scale datasets by region and season and apply life-cycle assessment techniques as well as experiment with specific types of interventions like nudges, price schemes, or certification campaigns. External validity would also be enhanced through comparison of the regional studies and through situating the CE trajectory of Sri Lanka in the wider global perspective. In line with this, the idea of integrating the principles of CE in the hospitality industry of Sri Lanka is an environmental requirement and a strategic requirement. By working on the inefficiencies of the resource consumption and taking advantage of the rising levels of tourist cognisance, the sector can cut down on ecological footprint besides increasing competitiveness in the world markets which are fast becoming more competitive by incorporating the element of sustainability. The facts used in this paper have confirmed that CE implementation can provide quantifiable benefits to the environmental welfare and economic stability to make Sri Lanka a pioneer in the sustainable hospitality in the region. Future research needs to increase its geographical and seasonal coverage, conduct life-cycle analysis, and experiment with interventions, such as eco-certifications and behavioral nudges. CE adoption, operational productivity, and sustainability could be improved with the help of comparative and cross-country studies and digital technologies such as an Internet of Things and artificial intelligence. The study will inform policymakers and hotels on how to minimize environmental effects and increase competitiveness in the tourism industry in Sri Lanka in terms of sustainability.

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