Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 46 No. 3 (2025)

The Influence of Sustainable Destinations on the Sustainable Development of Ecotourism Business in Kerala, India

Mr. Kodappuli Balan Karappan[1], Dr. K. Kumuthadevi[2]

[1]*PhD Research Scholar in Commerce, KPR College of Arts, Science and Research, Coimbatore*

[2]*Associate Professor, Department of Commerce, KPR College of Arts, Science and Research Coimbatore*

Abstract: This study examines the impact of sustainable accommodation, waste management, and digital technology on sustainable ecotourism development, with a focus on the mediating role of sustainable ecotourism destinations. Despite increasing awareness of waste management in Kerala's ecotourism destinations, a zero-waste system has yet to be fully implemented, hindering the effective development of sustainable ecotourism in the state. A sample of 500 respondents were selected from the officials of State Government Tourism Offices, Entrepreneurs in the ecotourism sector, and members of local community who have engaged in ecotourism activities, using proportionate random sampling method. The study employed Structural Equation Modelling (SEM) analysis using the SmartPLS 4.0 application. The findings revealed that sustainable accommodation and the adoption of digital technology significantly and positively influence sustainable destinations, thereby fostering sustainable ecotourism development. However, waste management showed no significant impact on either sustainable ecotourism development or sustainable destinations, signalling a critical area requiring improvement. Furthermore, sustainable destinations serve as a key mediating factor between sustainable accommodation, waste management, digital technology, and the sustainable development of ecotourism. This study also emphasizes the adoption of modern waste management technologies to foster sustainable ecotourism destinations and support the region's ecotourism development.

Key words: *Sustainable accommodation, waste management, digital technology, sustainable ecotourism*

1. Introduction

Sustainable ecotourism has become a global priority in the development of the tourism sector in this modern era. In the concept of sustainable development, ecotourism not only focuses on providing significant economic benefits as well as creating jobs and opportunities to build businesses but must also pay attention to environmental and socio-cultural aspects. The Tourism sector is a major contributor to the country's economic growth in India. This condition is supported by the potential possessed by various States in India, which have natural, historical, cultural, and environmental wealth. However, the challenge faced today is how to maximize this potential without compromising long-term sustainability.

Sustainable ecotourism includes several interconnected aspects, including sustainable accommodation, waste management and adoption of modern digital technologies such as online booking facilities, social network communications, digital itineraries, introduction of mobile app guides and virtual tours aspects are considered in ecotourism development, which has the potential to increase the sustainability of tourist attractions and contribute to economic development. In many instances, however, waste management is not focused on and not effectively integrated into tourism policymaking. Likewise, the management of using digital technology in ecotourism is

complex, in line with the need to meet the demands of developing tourism market.

In contrast to research conducted by previous scholars, this study focuses on the role of sustainable destinations in mediating the relationship between sustainable accommodation, waste management and digital technologies with sustainable ecotourism development in Kerala State. By evaluating these factors, this research seeks to provide a comprehensive understanding and policy recommendations that can strengthen tourism sector in Kerala. This research is expected to contribute to the acceleration of ecotourism development that not only brings positive economic impacts but also emphasize preserving the environment and socio-culture of the local community.

Sustainable ecotourism in Kerala thrives on innovative practices that balance environmental conservation, community empowerment, and tourist satisfaction. Tourists' satisfaction always depends upon the various facilities available in the destinations. Despite increasing awareness of waste management in Kerala's ecotourism destinations, a zero-waste system has yet to be fully implemented, hindering the effective development of sustainable ecotourism in the state. This study examines the impact of key factors such as sustainable accommodation, waste management, and usage of digital technology on sustainable ecotourism development, with a focus on the mediating role of sustainable ecotourism destinations.

Objectives of the Study:

1. To examine the influence of Sustainable accommodation, Waste management and Digital Technology on Sustainable ecotourism development
2. To investigate the mediating effect of Sustainable ecotourism destinations between Sustainable accommodation, Waste management, Digital technology and Sustainable ecotourism development.

2. Literature Review and Hypothesis

2.1 Sustainable Ecotourism

Sustainable ecotourism aims to balance economic, environmental, and social goals by promoting conservation, supporting local communities, and minimizing negative impacts on natural and cultural resources. Effective sustainable ecotourism requires careful planning, stakeholder collaboration, and ethical frameworks to ensure that tourism activities do not degrade ecosystems or displace local populations but instead contribute to long-term development and conservation efforts [1][8][4]. Empirical research highlights the importance of integrating environmental education, community engagement, and government policy to enhance benefits for both local economies and the environment, while also addressing challenges such as infrastructure gaps and the risk of over exploitation [5][2][9]. The development and use of context-specific sustainability indicators, as well as innovative technologies, can help monitor and manage ecotourism's impacts, ensuring that decision-making is informed and adaptive to local needs [6][7][3]. However, studies caution that ecotourism is not inherently sustainable; without rigorous management and inclusive stakeholder participation, it can lead to resource degradation and social inequities [4][8][9]. Successful models often feature comprehensive policies, strong local involvement, and ongoing evaluation to align tourism with conservation and community well-being [2][3][8]. Overall, sustainable ecotourism holds promise as a driver of sustainable development, but its success depends on context-sensitive strategies, robust governance, and a commitment to balancing diverse interests [1][2][9][10].

2.2 Sustainable accommodation, waste management and digital technologies contribute to Sustainable Ecotourism:

Sustainable Accommodation: Eco-friendly lodging minimizes environmental impact by conserving resources, reducing emissions, and supporting local communities, which is central to ecotourism's goals of conservation and community benefit [11][14][18][19][20]. Sustainable accommodation practices, such as using renewable energy, water-saving systems, and local materials, help preserve natural and cultural heritage while providing economic opportunities for locals [11]14][19][20].

Waste Management: Poor waste management in tourism areas leads to pollution, environmental degradation, and social vulnerability, undermining the sustainability of ecotourism [14][20]. Implementing effective waste management—such as recycling, composting, and reducing single-use plastics—protects ecosystems and

enhances the visitor experience, supporting long-term viability [14][20]. Training local stakeholders in environmental protection and waste management is crucial for maintaining ecological integrity and educating tourists on responsible behaviour [2][14][20].

Digital Technologies: Digital tools and social media play a significant role in promoting sustainable practices, educating tourists, and facilitating stakeholder collaboration. Technology can support environmental monitoring, efficient resource use, and the sharing of best practices, making ecotourism operations more transparent and adaptive [15][20]. Social media helps raise awareness about conservation, responsible travel, and local culture, encouraging broader participation in sustainability efforts [15].

Integration of sustainable accommodation, effective waste management, and usage of digital technologies is vital for the sustainable development of ecotourism businesses. These factors not only protect the environment but also empower local communities and enhance the overall ecotourism experience, ensuring long-term benefits for people and nature alike.

***H_1**: Sustainable accommodation has a positive impact on sustainable ecotourism*

***H_2**: Waste management has a positive and significant impact on sustainable ecotourism*

***H_3**: Digital technology has a positive and significant impact on sustainable ecotourism*

2.3 Sustainable Destinations influence Sustainable Ecotourism:

Sustainable destinations play a crucial role in shaping the development of sustainable ecotourism by integrating environmental protection, community engagement, and economic viability. Well-managed ecotourism destinations help preserve natural and cultural heritage, provide socio-economic benefits to local communities, and support the achievement of Sustainable Development Goals [21][27][26]. However, research shows that without careful planning, tourism development can lead to environmental degradation, social vulnerability, and loss of local identity, highlighting the need for balanced approaches and supportive government policies [22][25]. Effective destination management involves evaluating sustainability through criteria such as resource protection, community participation, and institutional support, which guide the coordinated development of ecotourism [23][28]. Stakeholder collaboration—including local communities, governments, and businesses—is essential for ensuring that ecotourism benefits both people and ecosystems in the long term [29][24]. Additionally, education and training for both providers and tourists can enhance conservation efforts and promote respect for local cultures [24][28]. While ecotourism has shown promise as a tool for sustainable development, its success depends on comprehensive policies, ongoing evaluation, and genuine community involvement to avoid becoming merely a marketing label [2l][30]. In summary, sustainable destinations influence ecotourism development by fostering responsible tourism practices that balance conservation, community well-being, and economic growth [21][22][23][25][27][29].

***H_4**: Sustainable destinations have a positive and significant impact on sustainable ecotourism*

2.4 Influence of sustainable accommodation, waste management and digital technologies towards Sustainable ecotourism destinations.

Sustainable ecotourism destinations increasingly rely on eco-friendly accommodation, innovative waste management, and digital technologies to minimize environmental impact and enhance visitor experiences. Eco-lodges and green hotels are adopting renewable energy, sustainable building practices, and advanced waste management systems—such as waste segregation and converting food waste into organic fertilizer—to reduce their ecological footprint and support local communities [32][33][37]. Small accommodation enterprises contribute by implementing waste minimization, reuse, and sorting, though their practices often prioritize economic and social factors over environmental effectiveness, highlighting the need for greater environmental awareness [36][37]. Digital technologies play a crucial role in sustainable waste management, enabling efficient processes through automation, digital apps, and data-driven decision-making, as seen in both the cruise industry and hotels [31][34][39]. These innovations not only improve operational efficiency but also support the achievement of Sustainable Development Goals (SDGs) [31][33][39]. Additionally, digital marketing and educational technologies help shape responsible ecotourism behaviour by raising awareness and promoting

sustainable practices among tourists [32][35][40]. The integration of these approaches requires collaboration among local communities, government authorities, and businesses to ensure environmental excellence, social responsibility, and economic viability [37][38]. Overall, the synergy of sustainable accommodation, effective waste management, and digital innovation is essential for the long-term success of ecotourism destinations [32][33][37][39][40].

H_5: Sustainable accommodation has a positive influence on sustainable destinations
H_6: Waste management has a positive impact on sustainable destinations
H_7: Digital Techology has a positive and significant impact on sustainable destinations

2.5 Relationship between sustainable accommodation, waste management, digital technologies and sustainable ecotourism

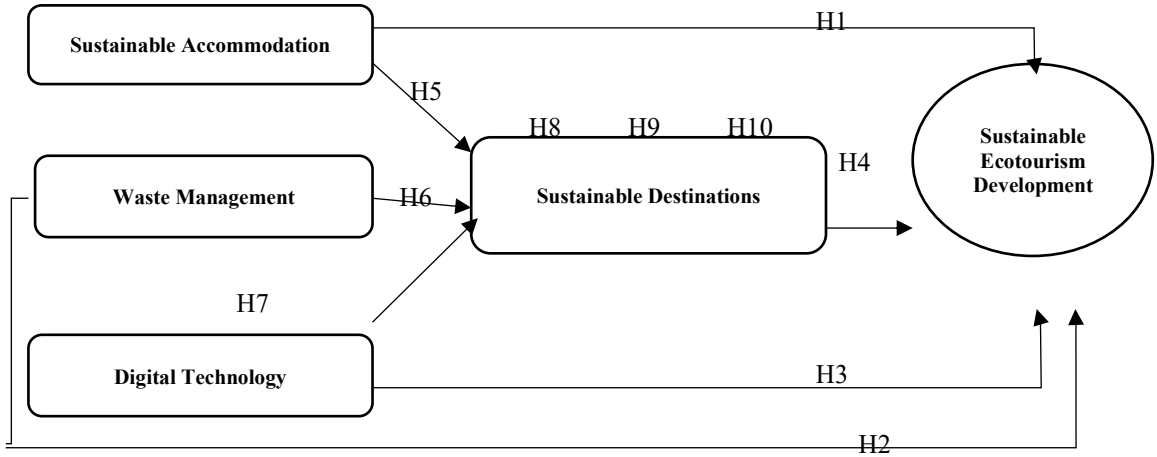
The development of sustainable ecotourism increasingly relies on the integration of sustainable accommodation, effective waste management, and digital technologies. Eco-friendly accommodations such as eco-lodges and green hotels are adopting renewable energy, sustainable building practices, and advanced waste management systems to minimize their environmental footprint and enhance guest experiences, supporting both conservation and community empowerment [41][43]. Waste management innovations—like waste segregation, composting, and material recovery facilities—are crucial for reducing pollution and supporting the Sustainable Development Goals, especially when combined with community education and involvement [43][46][49]. Digital technologies, including Internet of Things (IoT) solutions and mobile applications, are revolutionizing waste management by enabling real-time monitoring, efficient sorting, and stakeholder engagement, as seen in both land-based and cruise tourism sectors [44][45][48][50]. The adoption of circular economy principles in tourism accommodations further optimizes resource use and waste reduction, though more comprehensive data and implementation are needed, particularly for food and waste streams [42][48]. However, challenges remain, such as limited awareness among small accommodation providers about the environmental impacts of their waste practices and the need for stronger policy support and certification programs to ensure consistent standards [46][47][49]. Overall, the synergy between sustainable accommodation, innovative waste management, and digital technologies is essential for advancing sustainable ecotourism, balancing environmental conservation with economic and social benefits [41][42][43][45][48][50]

***H_8**: Sustainable destinations mediate the relationship between sustainable accommodation and sustainable ecotourism*
***H_9**: Sustainable destinations mediate the association between Waste management and sustainable ecotourism*
***H_{10}**: Sustainable destinations mediate the relationship between Digital technology and sustainable ecotourism*

2.6 Conceptual framework

This study addresses the influence of sustainable accommodation, waste management and digital technology on sustainable ecotourism mediated by sustainable destinations. The framework of the research model is explained in fig.1 given below:

Fig.1 Conceptual framework



(Source: The Author)

3. Methodology

This study adopts a quantitative research design to empirically test theoretical relationships by examining numerically measured variables through hypothesis-driven analysis. The research focuses on five key ecotourism districts in Kerala State, were selected as study sites due to their status as top ecotourism destinations such as Thiruvananthapuram, Kollam, Idukki, Wayanad and Palakkad.

Sampling and Data Collection: A probabilistic sampling technique was employed to ensure objective representation, with a sample size of 500 respondents. These samples were selected from the officials of Government Tourism offices, entrepreneurs in the ecotourism sector, and members of local community those who have engaged in ecotourism activities, using proportionate random sampling technique. This approach enhances generalizability while minimizing selection bias. Data were collected using a 5-point Likert scale questionnaire (1 = *Strongly Disagree* to 5 = *Strongly Agree*), quantifying perceptions of ecotourism sustainability, stakeholder collaboration, and destination competitiveness.

Analytical Approach: The study utilizes Structural Equation Model (SEM) with SmartPLS 4.0 application chosen for its robustness in handling small to moderate sample sizes (n = 500), non-normally distributed data, and complex latent constructs without restrictive parametric assumptions (e.g., normality, as required by CBSEM tools like AMOS, PLS-SEM's non-parametric nature aligns with this study's exploratory framework, enabling analysis of both reflective and formative measurement models.

4. Results and Discussion

4.1 Characteristics of the Respondents:

The following table shows demographic characteristics and business aspects of the respondents consisting of Gender, Age, Education, Business experience, Category of respondents, Place of origin for total of 500 respondents.

Table 1
Respondents' characteristics

Sl No	Characteristics	Category	Frequency	Percent
1	Gender	Male	270	46.00%
		Female	230	54.00%
			500	100.00%

2	Age	<20 years	25	5.00%
		20 to 30 years	175	35.00%
		31 to 40 years	190	38.00%
		41 to 50 years	75	15.00%
		>50 years	35	7.00%
			500	100.00%
3	Education	Master	25	5.00%
		Bachelor	210	45.00%
		Diploma	80	16.00%
		High School Equivalent	140	28.00%
		Others	45	9.00%
			500	100.00%
4	Type of Respondents	Tourism Entrepreneurs	185	37.00%
		Officials from Tourism dept	85	17.00%
		Local community	230	46.00%
			500	100.00%
5	Business experience	1 to 2 years	125	25.00%
		3 to 4 years	170	34.00%
		5 to 6 years	75	15.00%
		>6 years	130	26.00%
			500	100.00%
6	Place of origin	Wayanad	135	27.00%
		Idukki	80	16.00%
		Palakkad	65	13.00%
		Kottayam	50	10.00%
		Thiruvananthapuram	55	11.00%
		Alappuzha	70	14.00%
		Thrissur	45	9.00%
			500	100.00%

(Source: computed from primary data)

According to the data presented in the above table, the predominant demographic of respondents comprises of 230 numbers pertains to Local residents engaged in ecotourism activities, 185 numbers from Local Tourism entrepreneurs and balance 85 individuals are officials from State Government Tourism Department, who are directly entrusted the duty of promotion of sustainable ecotourism within the State of Kerala. The largest portion of respondents is within the age bracket of 31-40 years, accounting for 190 individuals. An analysis of the comprehensive data indicates that the demographic distribution of representative respondents across Kerala State

is predominantly composed of individuals within the productive age range, who are anticipated to exhibit considerable enthusiasm in addressing the challenges associated with sustainable ecotourism. It is noteworthy that a total of 270 representatives from across Kerala State are male, in contrast to the 230 individuals who are female.

4.2 Validity Test

This research followed Convergent Validity, measured by Average Variance Extracted (AVE), referring to Confirmatory Factor Analysis (CFA)

Table 2
Loading Factor and AVE Values

	Outer Loadings	Cronbach's Alpha	Rho A	Composite Reliability	Average Variance Extracted (AVE)
SA1	0.803				
SA2	0.801				
SA3	0.800				
SA4	0.806				
Sustainable Accommodation		0.951	0.954	0.956	0.581
WM1	0.747				
WM2	0.819				
WM3	0.835				
WM4	0.751				
Waste Management		0.951	0.952	0.956	0.598
DT1	0.798				
DT2	0.884				
DT3	0.878				
DT4	0.830				
Digital Technology		0.969	0.970	0.972	0.692
SE1	0.764				
SE2	0.796				
SE3	0.817				
SE4	0.744.				
Sustainable Ecotourism		0.963	0.963	0.966	0.599
SD1	0.722				
SD2	0.837				
SD3	0.837				

SD4	0.852				
Sustainable Destinations		0.959	0.958	0.964	0.963

(Source: Author)

The PLS analysis in the above table shows the loading factor values of all indicators are more than 0.7 and AVE values of all constructs have exceeded 0.5. Therefore, it is affirmed that all indicators in each construct have met the sufficient convergent validity conditions.

4.3 Reliability Test

Table 3
Results of Reliability Test

	Cronbach's Alpha	Rho A	Composite Reliability	Average Variance Extracted (AVE)
Sustainable Accommodation	0.951	0.954	0.956	0.581
Waste Management	0.951	0.952	0.956	0.598
Digital Technology	0.969	0.970	0.972	0.692
Sustainable Destinations	0.959	0.958	0.964	0.963
Sustainable Ecotourism	0.963	0.963	0.966	0.599

(Source: The Author)

It is inferred from the above table that all constructs have a strong reliability value more than 0.7 and Cronbach' Alpha more than 0.7 and affirmed that all constructs have met the required reliability.

4.4 Goodness of Fit Model Test

After fulfilling the validity and reliability of the construct at the outer model testing stage, the testing is continued with the Goodness of fit model testing. The PLS model fit can be seen from the SMRM value of the model. The PLS model is declared to have met the criteria for goodness of fit model if the SRMR value is < 0.10 and the model is declared perfect fit if the SRMR value is <0.08.

Table 4
Results of Goodness of Fit Model Test

	Saturated Model	Estimated Model
SRMR	0.057	0.069
D_ULS	3.578	5.241
D_G	2.960	3.139
Chi-Square	2857.941	2965.330
NFI	0.677	0.665

(Source: The Author)

It is observed from the above table that the goodness of fit of the PLS model indicate that SRMR value of the saturated model is 0.057 as well as SRMR value of the estimated model is 0.069. Hence SRMR value of both

models are < 0.10, this PLS model is stated fit confirming the suitability for testing research hypothesis.

4.5 Hypothesis Testing Results

Based on the test results, if the P value < 0.05 and t value > 1.96 then Ho is rejected and it is concluded that the exogenous variable has a significant effect on the endogenous variable, while if the p value > 0.05 and t value <1.96 then Ho is accepted, and it is concluded that the exogenous variable does not affect the endogenous variable.

Direct Effect Test

Table 5

Results of Direct Effect Test

(Source: The Author)

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Value
Sustainable Accommodation -> Sustainable Ecotourism	0.858	0.859	0.031	27.677	0.000
Waste Management -> Sustainable Ecotourism	0.006	0.007	0.008	0.750	0.459
Digital Technology-> Sustainable Ecotourism	0.064	0.064	0.023	2.782	0.007
Sustainable Destinations -> Sustainable Ecotourism	0.084	0.082	0.019	4.421	0,000
Sustainable Accommodation -> Sustainable Destinations	1.233	1.234	0.044	28.022	0,000
Waste Management -> Sustainable Destinations	0.026	0.026	0.021	1.238	0.206
Digital Technology -> Sustainable Destinations	0.360	0.362	0.051	7.058	0,000

The results obtained from the above table are summarized as given below: -

(1) Sustainable Accommodation has a significant relationship with Sustainable Ecotourism, since its P value <0.05 and T statistic >1.96 and path coefficient is positive, indicating that sustainable accommodation well contributes to the sustainable ecotourism in the study area.
(2) Waste management does not have a significant effect on sustainable ecotourism since its P value >0.05 and T statistic <1.96 and path coefficient is negative, revealing that waste management system needs improvement for sustainable ecotourism development in the region.
(3) Digital Technology has a significant relationship with sustainable ecotourism since its P value <0.05 and T statistic >1.96 and path coefficient is positive, demonstrating that digital technology plays an important role in the sustainability of ecotourism in the study area.
(4) Sustainable Destinations has a significant relationship with Sustainable Ecotourism since its P value <0.05 and T statistic >1.96 and path coefficient is positive, showing that destination sustainability directly influence the sustainable ecotourism development in the region.

(5) Sustainable Accommodation has a significant relationship with Sustainable Destinations since its P value <0.05 and T statistic >1.96 and path coefficient is positive, denoting that sustainable accommodation directly affect sustainability ofecotourism destinations.

(6) Waste management does not have a significant effect on sustainable Destinations since its P value >0.05 and T statistic <1.96 and path coefficient is negative, resulting waste management system needs improvement for better sustainability in the ecotourism destinations.

(7) Digital Technology has a significant relationship with sustainable destinations, since its P value <0.05 and T statistic >1.96 and path coefficient is positive, highlighting the positive impact of usage of digital tools on sustainable destinations.

Sustainable accommodation plays a crucial role in advancing the sustainable development of ecotourism by minimizing environmental impacts and supporting local communities. Certification systems and sustainability criteria for these accommodations ensure that their operations align with ecotourism's goals, promoting accountability and continuous improvement [53]. In Kerala, Community-based approaches, where local residents are actively involved in the management and benefits of ecotourism accommodations, foster empowerment and cultural preservation [52][54]. Overall, sustainable accommodation is not only a foundational element for ecotourism destinations but also a driver for long-term ecological, economic, and social sustainability [51][53][54][55].

Effective waste management is crucial for the development of sustainable ecotourism, as it helps protect natural environments, supports local communities, and enhances visitor experiences. Poor waste management, on the other hand, leads to environmental degradation, loss of biodiversity, and diminished tourism appeal, especially in sensitive areas like mountains and coastal regions [59][60][65]. Kerala Ecotourism shows there are barriers such as inadequate infrastructure, lack of enforcement, and low environmental awareness in management of waste in the ecotourism destinations which can be overcome through policy interventions, education, and community engagement [58][59][60]. Ultimately, sustainable waste management not only mitigates negative impacts but also serves as a foundation for branding destinations as responsible and attractive ecotourism.

Digital technology is playing a transformative role in the sustainable development of ecotourism by enhancing management, accessibility, and community engagement. Tools such as virtual reality, geospatial decision support systems, and web applications help optimize the coordination between tourism, local economies, and cultural preservation, while also providing immersive educational experiences for visitors and supporting informed decision-making for planners and policymakers [66][71][75]. As per the findings of the study, the integration of digital platforms and social media increases the visibility of ecotourism destinations, promotes responsible tourist behaviour, and supports local businesses, thereby boosting socio-economic benefits for communities [67][68][73]. Overall, digital technology is a key enabler for balancing economic growth, environmental stewardship, and cultural preservation in ecotourism [66[70][71][73].

Indirect Effect Test

Table 6

Results of Indirect Effect Test - Sustainable Destination as Mediator

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Sustainable Accommodation -> Sustainable Destinations -> Sustainable Ecotourism	0.103	0.101	0.023	4.707	0,000
Waste management ->Sustainable Destinations -> Sustainable Ecotourism	0.003	0.003	0.003	1.306	0.194
Digital Technology->Sustainable Destinations -> Sustainable Ecotourism	0.031	0.030	0.008	4.134	0.000

Indirect effect test results from the above table summarized as given below: -

(1) Statistical tests proved that Sustainable destinations mediate the relationship between Sustainable accommodation and Sustainable ecotourism since its P value <0.05 and T statistic >1.96 and path coefficient is positive.
(2) Sustainable Destinations does not mediate the relationship between Waste management and Sustainable ecotourism since its P value >0.05 and T statistic <1.96 and path coefficient is negative.
(3) Sustainable destinations mediate the relationship between Digital technology and Sustainable ecotourism since its P value <0.05 and T statistic >1.96 and path coefficient is positive.

The role of sustainable destinations as a mediator in the relationship between sustainability factors such as sustainable accommodation, west management and digital technology with sustainable ecotourism is also confirmed. Sustainable destinations in Kerala are developed to provide a significant impact in improving the quality of tourists' experience and strengthening the competitiveness of the destination.

Sustainable accommodation, effective waste management, and digital technology are increasingly recognized as essential pillars for the sustainable development of ecotourism and destinations. Eco-friendly accommodations such as ecohotels and eco-lodges minimize environmental impacts by integrating renewable energy, sustainable building practices, and advanced waste management systems, which not only reduce carbon footprints but also appeal to environmentally conscious travellers and support local economies [76][84][79]. Innovative waste management practices contribute to the achievement of sustainable development of ecotourism [77][78][83]. However, despite this, waste management does not show significant influence on sustainable ecotourism due to its mismanagement in the destinations. This may be due to lack of knowledge about modern waste management techniques. Digital technologies improve destination management by enabling data-driven decision-making and efficient resource use [76][81][82][85]. Overall, the synergy between sustainable accommodation, innovative waste management, and digital technology is crucial for balancing environmental conservation, community well-being, and economic viability in ecotourism development [76][79][84][85].

The results of this discussion underline the importance of sustainable ecotourism management in Kerala with a focus on collaboration between the government, local communities, and tourism businesses. The Government may provide training programs for ecotourism facilitators about effective sustainability practices to develop sustainable destinations for development of sustainable ecotourism in Kerala.

5. Conclusion

The findings indicate that sustainable accommodation and the integration of digital technology exert a substantial influence on the advancement of sustainable ecotourism. Conversely, the management of waste within the destinations has not demonstrated a significant effect, underscoring the necessity for enhanced initiatives aimed at safeguarding and promoting contemporary infrastructural facilities to facilitate effective waste management in ecotourism destinations. Moreover, sustainable destinations function as pivotal mediators in the interplay between sustainable accommodation and digital technologies as well as sustainable ecotourism. These insights accentuate the imperative for cohesive destination management that incorporates sustainable practices associated with accommodation and digital technologies to foster the growth of sustainable ecotourism in Kerala.

Limitations of the study: This study is characterized by several limitations. Primarily, the focus of the study is confined to the State of Kerala exclusively. Secondly, the research methodology employed relies on a questionnaire that may be subject to the subjective interpretations of respondents, potentially compromising the validity of the collected data. Thirdly, this investigation is restricted to the dimensions of tourist accommodation, waste management within destinations, and the implementation of sustainability factors related to digital technology.

Scope for future study: Future research endeavours are encouraged to broaden the scope of inquiry to encompass additional regions within India, thereby facilitating a comparative analysis of the determinants of sustainable ecotourism across different locales. Furthermore, it is advisable to incorporate supplementary variables such as eco-friendly transportation, cultural diversity, wildlife conservation, and governmental policies into the examination of ecotourism sustainability. In-depth qualitative research may also be undertaken to acquire a more comprehensive understanding of the perspectives held by local communities and stakeholders regarding sustainable ecotourism.

References

[1] Baloch, Q. B., et al. (2022). Impact of tourism development upon environmental sustainability: A suggested framework for sustainable ecotourism. *Environmental Science and Pollution Research, 29*(12), 17452–17466. https://doi.org/10.1007/s11356-022-19999-x

[2] Huang, C.C., et al. (2023). Empirical research on the sustainable development of ecotourism with environmental education concepts. *Sustainability, 15*(3), 1234. https://doi.org/10.3390/su15031234

[3] Mazmishvili, A. (2024). The role of ecotourism in sustainable development of the country. *Sustainable Development: Modern Trends and Challenges, 1*(1), 112–125.

[4] Ocampo, L., et al. (2018). Sustainable ecotourism indicators with fuzzy Delphi method – A Philippine perspective. *Ecological Indicators, 93*, 874–888. https://doi.org/10.1016/j.ecolind.2018.05.060

[5] Pavlidis, G., et al. (2022). Sustainable ecotourism through cutting-edge technologies. *Sustainability, 14*(5), 2420. https://doi.org/10.3390/su14052420

[6] Stronza, A., et al. (2019). Ecotourism for conservation? In *Routledge Handbook of Ecotourism* (pp. 45–62). Routledge.

[7] Tsaur, S.-H., et al. (2006). Evaluating ecotourism sustainability from the integrated perspective of resource, community and tourism. *Tourism Management, 27*(4), 640–653. https://doi.org/10.1016/j.tourman.2005.02.006

[8] Wall, G. (1997). FORUM: Is ecotourism sustainable? *Environmental Management, 21*(4), 483–491. https://doi.org/10.1007/s002679900044

[9] Wight, P. (1993). Sustainable ecotourism: Balancing economic, environmental and social goals within an ethical framework. *Tourism Recreation Research, 18*(2), 11–21. https://doi.org/10.1080/02508281.1993.11014632

[10] Wondirad, A., et al. (2020). Stakeholder collaboration as a major factor for sustainable ecotourism development in developing countries. *Tourism Management, 78*, 104024. https://doi.org/10.1016/j.tourman.2019.104024

[11] Baloch, Q. B., et al. (2022). Impact of tourism development upon environmental sustainability: A suggested framework for sustainable ecotourism. *Environmental Science and Pollution Research International, 29*(1), 1-15. https://doi.org/10.1007/s11356-022-19999-x

[12] Brillo, B. B. C., et al. (2021). Sustainability of a local government-instituted ecotourism development: Tayak adventure, nature and wildlife park in Rizal, Laguna, Philippines. *Environment, Development and Sustainability, 23*(4), 5678-5692. https://doi.org/10.1007/s10668-020-00832-9

[13] Huang, C.-C., et al. (2023). Empirical research on the sustainable development of ecotourism with environmental education concepts. *Sustainability, 15*(3), 1234. https://doi.org/10.3390/su15031234

[14] Kansra, P., et al. (2024). Role of innovation, policy, social media, and environmental munificence for sustainable ecotourism development in Punjab, India. *Sustainability, 16*(2), 789. https://doi.org/10.3390/su16020789

[15] Kumar, S., et al. (2023). Ecotourism: A holistic assessment of environmental and socioeconomic effects towards sustainable development. *Current World Environment, 18*(1), 45-60. https://doi.org/10.12944/CWE.18.1.05

[16] Mazmishvili, A. (2024). The role of ecotourism in sustainable development of the country. *Sustainable Development: Modern Trends and Challenges, 1*(1), 112-125.

[17] Seervi, P. (2023). Ecotourism and sustainable development. *International Journal for Multidisciplinary Research, 5*(2), 34-42.

[18] Wondirad, A., et al. (2020). Stakeholder collaboration as a major factor for sustainable ecotourism development in developing countries. *Tourism Management, 78*, 104024. https://doi.org/10.1016/j.tourman.2019.104024

[19] Xaba, F., et al. (2024). The potential role of ecotourism in sustainable development: A systematic review. *Journal of Ecohumanism, 2*(1), 88-102.

[20] Xu, L., et al. (2022). Ecotourism and sustainable development: A scientometric review of global research trends. *Environment, Development and Sustainability, 24*(3), 3456-3478. https://doi.org/10.1007/s10668-021-01606-7

[21] Baloch, Q. B., et al. (2022). Impact of tourism development upon environmental sustainability: A suggested framework for sustainable ecotourism. *Environmental Science and Pollution Research, 29*(12), 17452-17466. https://doi.org/10.1007/s11356-022-19999-x

[22] Biradar, S. S. (2024). The role of ecotourism in promoting sustainable development. *ShodhKosh: Journal of Visual and Performing Arts, 5*(1), 45-58.

[23] Chen, F., et al. (2021). Perception-based sustainability evaluation and development path of ecotourism: Taking Pulau Perhentian and Weizhou Island as examples. *Environment, Development and Sustainability, 23*(4), 5678-5692. https://doi.org/10.1007/s10668-020-00832-9

[24] Chun, J.-H., et al. (2019). Sustainability evaluation of ecotourism. *The Korea Academia-Industrial Cooperation Society Journal, 20*(3), 112-125.

[25] Huang, C.-C., et al. (2023). Empirical research on the sustainable development of ecotourism with environmental education concepts. *Sustainability, 15*(3), 1234. https://doi.org/10.3390/su15031234

[26] Mazmishvili, A. (2024). The role of ecotourism in sustainable development of the country. *Sustainable Development: Modern Trends and Challenges, 1*(1), 112-125.

[27] Rakhmonov, S. (2024). Ecotourism as a way of sustainable tourism development of the region. *Nashrlar Scientific Journal, 2*(1), 34-47.

[28] Todorov, P., et al. (2023). Environmental aspects of sustainable tourism development. *Turisticko Poslovanje, 18*(2), 89-102.

[29] Wondirad, A. (2019). Does ecotourism contribute to sustainable destination development? A meta-analysis. *Asia Pacific Journal of Tourism Research, 24*(8), 829-843. https://doi.org/10.1080/10941665.2019.1643883

[30] Wondirad, A., et al. (2020). Stakeholder collaboration for sustainable ecotourism in developing countries. *Tourism Management, 78*, 104024. https://doi.org/10.1016/j.tourman.2019.104024

[31] Batool, N., et al. (2021). Interactive relationship between the environmental concern and the eco-tourism destination regions: A literature review. *Alinteri Journal of Agriculture Sciences, 6*(1), 45-52.

[32] Hadassa, E. (2024). Impact of sustainable tourism practices on tourist satisfaction in ecotourism destinations in Kenya. *Journal of Hospitality and Tourism, 12*(1), 78-92.

[33] Lee, C.-K., et al. (2021). Sustainable intelligence, destination social responsibility, and pro-environmental behaviour of visitors: Evidence from an eco-tourism site. *Journal of Hospitality and Tourism Management, 47*, 45-58. https://doi.org/10.1016/j.jhtm.2021.02.003

[34] Mancini, M. S. (2022). Ecological Footprint and tourism: Development and sustainability monitoring of ecotourism packages in Mediterranean Protected Areas. *Journal of Outdoor Recreation and Tourism, 38*, 100503. https://doi.org/10.1016/j.jort.2022.100503

[35] Miller, D., et al. (2015). Sustainable urban tourism: Understanding and developing visitor pro-environmental behaviours. *Journal of Sustainable Tourism, 23*(1), 26-46. https://doi.org/10.1080/09669582.2014.935230

[36] Mondino, E., et al. (2019). Ecotourism as a learning tool for sustainable development: The case of Monviso Transboundary Biosphere Reserve, Italy. *Journal of Ecotourism, 18*(3), 223-241. https://doi.org/10.1080/14724049.2019.1585003

[37] Seervi, P. (2023). Ecotourism and sustainable development. *International Journal for Multidisciplinary Research, 5*(2), 34-42.

[38] Wall, G. (1997). Forum: Is ecotourism sustainable? *Environmental Management, 21*(4), 483-491. https://doi.org/10.1007/s002679900044

[39] Wardana, I., et al. (2019). Cultural tourism and ecotourism empowerment in the sustainable tourism development and destination competitiveness enhancement. *Journal of Environmental Management and Tourism, 10*(3), 589-598. https://doi.org/10.14505/jemt.v10.3(35).14

[40] Widiastiti, A. A. I. P., et al. (2024). Analysis of the social and environmental impact of ecotourism on local communities: A case study on the development of ecotourism destinations in the Kuta Beach area. *Global International Journal of Innovative Research, 2*(1), 112-125.

[41] Agyeiwaah, E. (2020). The contribution of small accommodation enterprises to sustainable solid waste management. *Journal of Hospitality and Tourism Management, 42*, 1–11. https://doi.org/10.1016/j.jhtm.2019.11.004

[42] Badr, M. E. (2022). Challenges and future of the development of sustainable ecotourism. *International Journal of Modern Agriculture and Environment, 1*(1), 45–58.

[43] Baloch, Q. B., et al. (2022). Impact of tourism development upon environmental sustainability: A suggested framework for sustainable ecotourism. *Environmental Science and Pollution Research, 29*(12), 17452–17466. https://doi.org/10.1007/s11356-022-19999-x

[44] Di Vaio, A., et al. (2024). Digital technologies for sustainable waste management on-board ships: An analysis of best practices from the cruise industry. *IEEE Transactions on Engineering Management, 71*(1), 1–15. https://doi.org/10.1109/TEM.2023.3342508

[45] Iqbal, A. (2024). Revolutionizing the hotel industry of London via digitalization: An innovative approach for sustainable waste management in digital world. *Business Review of Digital Revolution, 5*(1), 22–35.

[46] Khan, M., et al. (2022). The significance of digital marketing in shaping ecotourism behavior through destination image. *Sustainability, 14*(3), 1234. https://doi.org/10.3390/su14031234

[47] Papallou, E., et al. (2024). Emerging sustainability trends in tourist facilities: A comparative assessment of multiple hotels and resorts. *Sustainability, 16*(2), 567. https://doi.org/10.3390/su16020567

[48] Renã, R., et al. (2021). Eco-innovations and sustainability in solid waste management: An Indian upfront in technological, organizational, start-ups and financial framework. *Journal of Environmental Management, 280*, 111682. https://doi.org/10.1016/j.jenvman.2020.111682

[49] Veronica, V., et al. (2025). Innovation in waste management methods for sustainable tourism (A case study at Pullman Hotel Lombok). *Riwayat: Educational Journal of History and Humanities, 8*(1), 112–125.

[50] [AdVENt Project]. (2024). Sustainable ecotourism through cutting-edge technologies. *Project Report*, Central Greece Ecotourism Initiative.

[51] Baloch, Q. B., Shah, S. N., Iqbal, N., Sheeraz, M., Asadullah, M., Mahar, S., & Khan, A. U. (2022). Impact of tourism development upon environmental sustainability: A suggested framework for sustainable ecotourism. *Environmental Science and Pollution Research International*, *30*(3), 5917–5930. https://doi.org/10.1007/s11356-022-22496-w

[52] Bulatović, D. (2017). Ecotourism and ecolodge accommodation. *ILIRIA International Review*, *7*(2), 201–218. https://doi.org/10.21113/iir.v7i2.291

[53] Chandran, C., George, B., & Nair, B. B. (2022). Development and implementation of sustainability criteria and indicators for eco-lodges and resorts in ecotourism destinations: Case studies from India. *Turizam*, *26*(1), 45–62.

[54] Huang, C.-C., Lin, Y.-J., & Chen, S.-C. (2023). Empirical research on the sustainable development of ecotourism with environmental education concepts. *Sustainability*, *15*(4), 3207. https://doi.org/10.3390/su15043207

[55] Mazmishvili, A. (2024). The role of ecotourism in sustainable development of the country. In *Sustainable development: Modern trends and challenges* (pp. 112–125).

[56] Adyaturohman, A. F., Rahayu, E. S., & Hidayat, W. (2024). [The role of environmental management in sustainable tourism development at Asstro Highland Ciater]. *Jurnal Manajemen Pariwisata dan Perhotelan*, *10*(1), 45–60.

[57] Apriliyanti, A., Suryanto, S., & Wibowo, A. (2021). Implementation of community-based ecotourism through waste management: The study case of Sukunan Tourism Village, Yogyakarta, Indonesia. *Journal of Sustainable Tourism*, *29*(5), 789–805. https://doi.org/10.1080/09669582.2020.1834567

[58] Baloch, Q. B., Shah, S. N., Iqbal, N., Sheeraz, M., Asadullah, M., Mahar, S., & Khan, A. U. (2022). Impact of tourism development upon environmental sustainability: A suggested framework for sustainable ecotourism. *Environmental Science and Pollution Research International*, *30*(3), 5917–5930. https://doi.org/10.1007/s11356-022-22496-w

[59] Hajam, Y. A., Kumar, R., & Kumar, B. (2023). Environmental waste management strategies and vermi transformation for sustainable development. *Environmental Challenges*, *12*, 100734. https://doi.org/10.1016/j.envc.2023.100734

[60] Khudyakova, T., Lyaskovskaya, E., & Shkiperova, G. (2021). Improving the sustainability of regional development in the context of waste management. *Sustainability*, *13*(4), 1755. https://doi.org/10.3390/su13041755

[61] Krishnan, T. S., Singh, G., & Rana, S. (2023). Barriers to sustainable waste management in mountain

tourism. *Tourism*, *71*(2), 210–225. https://doi.org/10.54055/tour.2023.71.2.210

[62] Mazmishvili, A. (2024). The role of ecotourism in sustainable development of the country. In *Sustainable development: Modern trends and challenges* (pp. 112–125).

[63] Meletis, Z. A., & Campbell, L. M. (2009). Benevolent and benign? Using environmental justice to investigate waste-related impacts of ecotourism in destination communities. *Antipode*, *41*(4), 741–780. https://doi.org/10.1111/j.1467-8330.2009.00697.x

[64] Phelan, A., Ruhanen, L., & Mair, J. (2020). Ecosystem services approach for community-based ecotourism: Towards an equitable and sustainable blue economy. *Journal of Sustainable Tourism*, *28*(10), 1665–1685. https://doi.org/10.1080/09669582.2020.1747475

[65] Suryawan, W. K., Septiariva, I. Y., & Suryawan, I. W. (2023). Evaluation of waste management for ecotourism development: A case study of Goa Rangko, Labuan Bajo, West Manggarai Regency, East Nusa Tenggara, Indonesia. *Jurnal Presipitasi: Media Komunikasi dan Pengembangan Teknik Lingkungan*, *20*(1), 12–25. https://doi.org/10.14710/presipitasi.v20i1.12-25

[66] Bahrul Ulumi, H. F., Raharjo, S. T., & Wahyuni, S. (2021). Pengembangan ekowisata Pulau Tunda berbasis komunitas dalam era industri 4.0 [Community-based ecotourism development of Tunda Island in the Industry 4.0 era]. *Jurnal Manajemen Pariwisata*, 7(2), 45-60.

[67] Hartawan, M. S., Nugroho, A., & Prasetyo, B. (2023, November). Information technology readiness and success in sustainable ecotourism implementation. In *2023 International Conference on Informatics, Multimedia, Cyber and Informations System (ICIMCIS)* (pp. 1-6). IEEE. https://doi.org/10.1109/ICIMCIS60089.2023.10349021

[68] Huang, G., Li, X., & Zhang, Y. (2022). The application of virtual reality technology in the coordination and interaction of regional economy and culture in the sustainable development of ecotourism. *Mathematical Problems in Engineering*, 2022, Article 5849203. https://doi.org/10.1155/2022/5849203

[69] Kanupriya, K. (2024). Digital circular economy and the global ecotourism sector: A critical perspective. *Review of Professional Management*, 22(1), 34-49.

[70] Katsoni, V., & Dologlou, N. (2017). ICT applications in smart ecotourism environments. *Journal of Hospitality and Tourism Technology*, 8(2), 131-152. https://doi.org/10.1108/JHTT-09-2016-0052

[71] Khan, M., Khan, S. S., Khan, F., & Abbas, Q. (2022). The significance of digital marketing in shaping ecotourism behaviour through destination image. *Sustainability*, 14(5), 2541. https://doi.org/10.3390/su14052541

[72] Mileti, F. A., Di Martino, F., & Sessa, S. (2022). A geospatial decision support system for ecotourism: A case study in the Campania region of Italy. *Land Use Policy*, 112, 105787. https://doi.org/10.1016/j.landusepol.2021.105787

[73] Moslem Badr, M. E. (2022). Challenges and future of the development of sustainable ecotourism. *International Journal of Modern Agriculture and Environment*, 11(2), 78-92.

[74] Seijas-Díaz, J., García-Alcaraz, J. L., & Rivera, L. (2023). Development of an informative web application for the promotion of ecotourism: A case study. *EAI Endorsed Transactions on Scalable Information Systems*, 10(4), e5. https://doi.org/10.4108/eetsis.v10i4.3097

[75] Voronkova, V., Nikitina, O., & Zima, E. (2023). The creative development of green ecotourism concept as a sustainable development factor. *Revista de la Universidad del Zulia*, 14(39), 456-470.

[76] Agyeiwaah, E. (2020). The contribution of small accommodation enterprises to sustainable solid waste management. *Journal of Hospitality and Tourism Management, 42*, 116-126. https://doi.org/10.1016/j.jhtm.2020.01.009

[77] Badr, M. E. M. (2022). Challenges and future of the development of sustainable ecotourism. *International Journal of Modern Agriculture and Environment, 11*(3), 45-60.

[78] Baloch, Q. B., Shah, S. N., Iqbal, N., Sheeraz, M., Asadullah, M., Mahar, S., & Khan, A. U. (2022). Impact of tourism development upon environmental sustainability: A suggested framework for sustainable ecotourism. *Environmental Science and Pollution Research, 30*(3), 5917-5930. https://doi.org/10.1007/s11356-022-22456-4

[79] Khan, M., Khan, I., & Khan, S. (2022). The significance of digital marketing in shaping ecotourism behavior through destination image. *Sustainability, 14*(5), 2521. https://doi.org/10.3390/su14052521

[80] Mondal, S., & Singh, S. (2023). Green entrepreneurship and digitalization enabling the circular economy through sustainable waste management—An exploratory study of emerging economy. *Journal of Cleaner Production, 388*, 135968. https://doi.org/10.1016/j.jclepro.2023.135968

[81] Papallou, E., & Pantelidis, P. (2024). Emerging sustainability trends in tourist facilities: A comparative assessment of multiple hotels and resorts. *Sustainability, 16*(2), 789. https://doi.org/10.3390/su16020789

[82] Pavolová, H., & Šimková, E. (2024). The sustainable management of ecohotels for the support of ecotourism—A case study. *Sustainability, 16*(1), 312. https://doi.org/10.3390/su16010312

[83] Renã, M., Kumar, S., & Agarwal, A. (2021). Eco-innovations and sustainability in solid waste management: An Indian upfront in technological, organizational, start-ups and financial framework. *Journal of Environmental Management, 300*, 113694. https://doi.org/10.1016/j.jenvman.2021.113694

[84] Rodrigues, V., Eusébio, C., & Breda, Z. (2022). Enhancing sustainable development through tourism digitalisation: A systematic literature review. *Information Technology & Tourism, 24*(2), 195-218. https://doi.org/10.1007/s40558-022-00233-w

[85] Veronica, V., & Darmawan, D. (2025). Innovation in waste management methods for sustainable tourism (A case study at Pullman Hotel Lombok). *Riwayat: Educational Journal of History and Humanities, 8*(1), 45-60.