

# PATHWAYS TO SUSTAINABLE ECOTOURISM PERFORMANCE: THE MEDIATING ROLE OF ECONOMIC SUSTAINABILITY AND THE EFFECTS OF COMMUNITY PARTICIPATION AND DIGITAL FORESTRY

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## ABSTRACT:

Sustainable ecotourism has become a vital strategy for balancing conservation, community well-being, and economic development. This study empirically examines the factors driving sustainable ecotourism performance by integrating community participation, digital forestry adoption, digital literacy, and economic sustainability within a structural framework. Primary data were collected from 350 respondents linked to ecotourism destinations, and the analysis employed a two-stage approach. First, multiple regression analysis assessed the individual impact of community participation and digital forestry adoption on economic sustainability. The results showed that both variables significantly and positively influence economic sustainability. Second, Structural Equation Modelling (SEM) using LISREL 8.80 was used to evaluate the measurement and structural models. The model demonstrated an excellent fit ( $\chi^2/df < 2$ , RMSEA = 0.015,  $p > 0.05$ ), confirming the robustness of the constructs. SEM results indicated that economic sustainability acts as a strong mediator connecting community participation and digital forestry adoption to sustainable ecotourism performance. Moreover, digital literacy enhanced the effectiveness of digital forestry adoption, emphasizing the moderating role of technological capability. Overall, the findings affirm that both community-based initiatives and technological advancements are crucial for improving sustainable ecotourism performance. The study offers significant managerial and policy implications for enhancing ecotourism practices, fostering stakeholder participation, and integrating digital tools into destination management.

**Keywords:** Sustainable Ecotourism | Community Participation | Digital Forestry Adoption | Economic Sustainability | Structural Equation Modelling (SEM)

## 1 INTRODUCTION:

Ecotourism has emerged as a critical pathway for achieving sustainability in the tourism sector by integrating conservation, community development, and responsible visitor engagement. As global environmental pressures intensify, ecotourism is increasingly recognised for its potential to support both biodiversity protection and local livelihoods (Honey, 2008; Lane, 1994). In the Indian context, the Ministry of Tourism has emphasized ecotourism as a strategic pillar for sustainable development, highlighting the need for community involvement, capacity-building, and technological integration in destination management (Ministry of Tourism, 2022). This shift aligns with global commitments, particularly the United Nations Sustainable Development Goals (UNWTO, 2018), which promote responsible consumption, environmental stewardship, and inclusive economic growth.

Community participation remains a cornerstone of sustainable ecotourism, as local residents often serve as custodians of natural and cultural resources. Effective involvement fosters stewardship, enhances local empowerment, and strengthens destination resilience (Forgeard, 2023; Stronza & Gordillo, 2008). Scholars argue that ecotourism initiatives are more likely to succeed when communities are incorporated into planning, decision-making, and benefit-sharing frameworks (Tiwari et al., 2024). However, challenges persist, particularly regarding unequal participation, lack of training, and limited access to development opportunities (Kumar et al., 2023).

In recent years, digital transformation has reshaped tourism operations, governance, and visitor behaviour. Advancements in ICT, smart technologies, and digital platforms have revolutionized destination management systems, resource monitoring, and sustainability reporting (Buhalis & Law, 2008; Gretzel et al., 2015). The emergence of Forest 4.0 technologies—such as drones, remote sensing, IoT-based forest monitoring, and GIS-enabled planning—have significantly improved conservation effectiveness and decision-making in forestry and ecotourism landscapes (Damaševičius et al., 2024; Forest Wildwood, 2024). These digital innovations enhance transparency, reduce risks, and support data-driven ecotourism management.

Digital literacy, however, plays a decisive role in the successful adoption of such tools. Without adequate digital skills, communities and stakeholders cannot fully benefit from emerging technologies (Al-Remedy, 2024). Studies suggest that digital literacy fosters innovation, improves communication, and enhances tourism sustainability by enabling better information access and adaptive capacity (Sigala, 2018; Sustainability Directory, 2025). As digital ecosystems continue to expand, bridging technological knowledge gaps becomes essential for maximizing the benefits of digital forestry and smart tourism solutions.

At the theoretical level, sustainable tourism development has been extensively debated. Liu (2003) and Hall (2019) highlight concerns about measurement complexity, multidimensionality, and the need for context-specific strategies. Contemporary research emphasizes quantifying sustainability performance at the destination level using integrated models that capture economic, social, and environmental dimensions (Torres-Delgado & Palomeque, 2014; Goslings et al., 2015). Against this backdrop, the integration of community participation, digital forestry adoption, and digital literacy into sustainable ecotourism research remains underexplored within emerging economies.

Given these gaps, the present study investigates the combined influence of community participation, digital forestry adoption, and digital literacy on economic sustainability and sustainable ecotourism performance. The study adopts a dual-method approach: Multiple Regression Analysis for direct predictors of economic sustainability, and Structural Equation Modelling (SEM) to test the overall causal framework. This integrated approach addresses calls by Nunkoo and Ramkissoon (2011, 2013) for more robust statistical techniques that capture complex relationships in tourism research.

## 2 LITERATURE REVIEW:

### 2.1 Community Participation and Economic Sustainability

Community participation is widely regarded as a cornerstone of ecotourism development because local communities serve as custodians of natural and cultural resources. When residents are directly involved in decision-making, destination planning, and operational activities, they gain equitable access to tourism benefits and develop stronger stewardship attitudes (Stronza & Gordillo, 2008). Meaningful participation reduces economic leakages and ensures that tourism-generated income remains within the community, thereby enhancing long-term financial stability and livelihood security. Studies on ecotourism have consistently emphasized that community-driven initiatives lead to higher sustainability outcomes, particularly in developing regions where tourism serves as a major economic driver (Tiwari et al., 2024; Kumar et al., 2023).

Based on this theoretical foundation, community involvement is expected to improve the financial viability of ecotourism destinations. Thus, the following hypothesis is proposed:

**H1:** Community Participation (CP) positively influences Economic Sustainability (ES).

### 2.2 Digital Forestry Adoption and Economic Sustainability

Digital transformation is reshaping tourism and environmental management through smart technologies, ICT systems, and data-driven decision-making (Buhalis & Law, 2008; Gretzel et al., 2015). In the forestry and ecotourism context, the emergence of Forest 4.0—including remote sensing, GIS mapping, drones, climate monitoring sensors, and IoT-based surveillance—has revolutionised conservation effectiveness (Damaševičius et al., 2024). These digital forestry tools support efficient resource monitoring, reduce operational costs, and minimise environmental risks, resulting in improved economic outcomes for ecotourism destinations.

Digital tools also facilitate visitor management, risk detection, and enhanced interpretive services, enabling operators to diversify revenue streams and strengthen environmental governance (Forest Wildwood, 2024). Since efficient forest management directly contributes to cost reductions and sustainable income generation, digital forestry adoption is expected to positively influence economic sustainability.

**H2:** Digital Forestry Adoption (DFA) positively influences Economic Sustainability (ES).

### 2.3 Economic Sustainability and Sustainable Ecotourism Performance

Economic sustainability is one of the key pillars of sustainable tourism, ensuring steady income flows, equitable benefit distribution, and long-term financial resilience (Torres-Delgado & Palomeque, 2014). The availability of stable economic benefits encourages communities to remain committed to conservation, strengthen environmental monitoring, and support responsible visitor practices. According to the triple-bottom-line (TBL) framework, economic viability enables investments in social development, infrastructure, and environmental protection (Hall, 2019; Liu, 2003).

In ecotourism destinations, high levels of economic sustainability translate into better support for environmental programs, improved service quality, and stronger destination competitiveness. Therefore, economic sustainability is expected to play a direct role in enhancing overall ecotourism performance.

**H3:** Economic Sustainability (ES) positively influences Sustainable Ecotourism Performance (SEP)

### 2.4 Community Participation and Sustainable Ecotourism Performance

Community participation enhances local governance, strengthens place attachment, and promotes responsible tourism practices (Forgeard, 2023). Residents who perceive tourism as beneficial are more likely to engage in conservation efforts, host cultural activities, and provide high-quality services to visitors (Intech Open, 2022). As a result, community involvement contributes directly to improved destination performance, ecosystem protection, and visitor satisfaction.

**H4:** Community Participation (CP) positively influences Sustainable Ecotourism Performance (SEP).

### **2.5 Mediation Role of Economic Sustainability**

Several authors argue that economic sustainability acts as a critical mechanism through which social and technological interventions translate into improved ecotourism outcomes (Kumar et al., 2023; Kumari, 2022). Community participation can enhance local earnings, employment, and entrepreneurial opportunities, which then motivate deeper involvement in sustainability practices. Similarly, digital forestry adoption reduces risks and improves operational efficiency, generating economic gains that subsequently support broader ecotourism development.

Thus, economic sustainability is positioned as a mediator, linking community participation and digital forestry adoption with sustainable ecotourism performance.

**H5:** Economic Sustainability (ES) fully mediates the relationship between Community Participation (CP) and Sustainable Ecotourism Performance (SEP).

**H6:** Economic Sustainability (ES) partially mediates the relationship between Digital Forestry Adoption (DFA) and Sustainable Ecotourism Performance (SEP).

### **2.6 Moderating Effect of Digital Literacy**

Digital literacy, defined as the ability to effectively use digital tools and platforms, is increasingly important in tourism and forestry operations (Al-Remedy, 2024). High digital competence enables stakeholders to interpret environmental data, operate digital forestry tools, and adopt smart management systems (Sigala, 2018). When digital literacy is strong, digital forestry adoption becomes more efficient, leading to improved ecological monitoring and enhanced sustainable tourism outcomes. Conversely, low digital literacy limits the benefits of technological investments and reduces the effectiveness of digital tools (Sustainability Directory, 2025).

Thus, digital literacy is expected to moderate the relationship between digital forestry adoption and sustainable ecotourism performance.

**H7:** Digital Literacy (DL) moderates the relationship between Digital Forestry Adoption (DFA) and Sustainable Ecotourism Performance (SEP), such that the positive effect is stronger under high DL conditions.

## **3 RESEARCH GAP:**

### **3.1 Theoretical Gap**

Although extensive studies have examined sustainable tourism, limited research integrates community participation, digital forestry adoption, digital literacy, and economic sustainability into a unified theoretical framework. Prior studies tend to explore these constructs independently without explaining *how* they interact to influence sustainable ecotourism performance. This results in a lack of theory-driven models capturing both community-based and technology-led sustainability drivers.

### **3.2 Empirical Gap**

Existing empirical studies predominantly rely on descriptive or correlation-based analysis. Very few studies combine Multiple Regression (for direct effects) and SEM (for structural relationships) to validate the multidimensional influence of community participation and digital technologies on economic sustainability and ecotourism performance. Additionally, evidence from Indian ecotourism destinations—especially involving digital forestry tools—is almost non-existent.

### **3.3 Methodological Gap**

Most ecotourism studies rely on qualitative approaches, case studies, or basic statistics. There is a lack of advanced modelling techniques, such as SEM using LISREL, which can simultaneously assess measurement validity and causal relationships. Furthermore, the moderating role of digital literacy has not been rigorously tested using structural modelling frameworks.

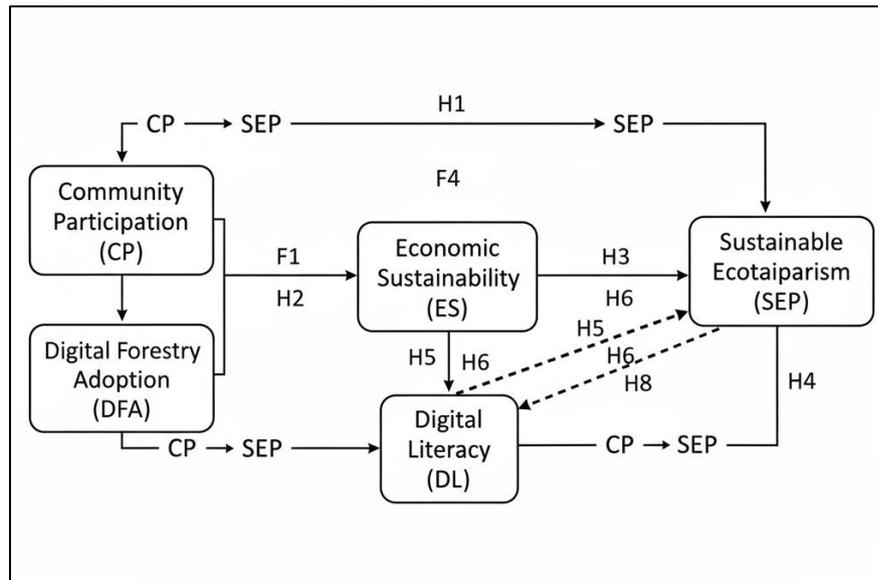
### **3.4 Contextual Gap**

Very few studies have evaluated sustainable ecotourism through the lens of Indian ecotourism destinations, despite India being one of the world's most ecologically diverse and culturally rich ecotourism regions. The integration of digital forestry technologies (Forest 4.0) within Indian ecotourism is a newly emerging area with limited scholarly attention.

### **3.5 Conceptual Gap**

The role of economic sustainability as a mediating variable linking community participation and digital forestry adoption to sustainable ecotourism performance remains largely unexplored. Likewise, digital literacy as a moderator influencing the technological sustainability pathway has not been conceptually established in prior models.

#### 4 CONCEPTUAL FRAMEWORK:



#### 5 STATEMENT OF THE PROBLEM

Sustainable ecotourism depends on the active involvement of local communities, the responsible use of natural resources, and the integration of modern technologies. However, despite the increasing national emphasis on ecotourism development, Indian destinations continue to face challenges such as insufficient community participation, limited knowledge of digital tools, and a lack of structured frameworks for measuring sustainability outcomes. While global research highlights the importance of ICT tools, digital literacy, and community Empowerment and empirical evidence from India—especially regarding digital forestry adoption—are limited. Additionally, the mechanisms through which community participation and digital technologies contribute to sustainable ecotourism performance remain unclear. There is an urgent need to evaluate whether economic sustainability serves as an important mediating factor in this process and whether digital literacy enhances the effectiveness of technology-driven initiatives. Therefore, a comprehensive empirical assessment using both Multiple Regression and Structural Equation Modelling (SEM) is necessary to identify the key determinants of sustainable ecotourism performance and to contribute to theory, practice, and policy development.

#### 6 OBJECTIVE OF THE STUDY:

To examine the direct influence of community participation and digital forestry adoption on economic sustainability using Multiple Regression Analysis.

To assess the structural relationships among community participation, digital forestry adoption, economic sustainability, digital literacy, and sustainable ecotourism performance using Structural Equation Modelling (SEM).

To evaluate the mediating role of economic sustainability and the moderating role of digital literacy in determining sustainable ecotourism performance.

#### 7 RESEARCH METHODOLOGY:

##### 7.1 Research Design

The present study adopts a quantitative, explanatory research design to investigate the relationships among Community Participation (CP), Digital Forestry Adoption (DFA), Economic Sustainability (ES), Digital Literacy (DL), and Sustainable Ecotourism Performance (SEP). A dual-method analytical approach was used. First, Multiple Regression Analysis (MRA) was conducted to examine the independent effects of CP and DFA on ES. Second, Structural Equation Modelling (SEM) using LISREL 8.80 was performed to validate the measurement model and test the structural relationships, including mediation and moderation effects. SEM is particularly suitable for this study as it enables simultaneous estimation of latent constructs and causal pathways, ensuring robust inferential validity. This approach follows methodological recommendations by Nunkoo and Ramkissoon (2011, 2013), emphasizing the need for advanced analytical models in tourism sustainability research.

##### 7.2 Research Instrument

A structured questionnaire was used as the primary research instrument. The questionnaire consisted of 33 items measuring five latent constructs:

- Community Participation (7 items)
- Digital Forestry Adoption (7 items)
- Economic Sustainability (7 items)
- Digital Literacy (5 items)
- Sustainable Ecotourism Performance (7 items)

All items were measured using a 5-point Likert scale ranging from 1 = “Strongly Disagree” to 5 = “Strongly Agree.” The constructs and scale items were adapted from validated instruments used in ecotourism, digital transformation, and sustainability research, ensuring both reliability and content validity. Prior to data collection, the questionnaire underwent a pilot test with 30 respondents to confirm clarity, internal consistency, and ease of understanding. Feedback from the pilot study resulted in minor wording modifications.

Internal reliability of the final instrument was assessed using Cronbach’s Alpha, with all constructs meeting the acceptable threshold ( $\alpha \geq 0.70$ ). The measurement model was later validated using SEM through Confirmatory Factor Analysis (CFA), establishing convergent validity, discriminant validity, and construct reliability through standardized loadings, Average Variance Extracted (AVE), and Composite Reliability (CR).

### 7.3 Data Collection Procedure:

The study utilized a primary data collection approach targeting individuals associated with ecotourism destinations, including local community members, tourism workers, forest guides, eco-facility staff, and visitors with experience in eco-sites. A purposive sampling technique was adopted to select respondents who possess relevant knowledge of ecotourism operations and technology usage within forest-based environments.

A total of 350 valid responses were collected. Data collection was conducted through a combination of online Google Forms and field-based surveys at selected ecotourism destinations. Respondents were briefed on the purpose of the research, assured confidentiality, and informed consent was obtained before participation. Incomplete or inconsistent responses were eliminated during data cleaning. The final dataset was exported to SPSS and LISREL for statistical analysis. The collected data underwent screening procedures, including checks for missing values, normality assessment, outlier detection, and multicollinearity testing prior to conducting regression and SEM analyses. This ensured the accuracy and robustness of the findings.

### 7.4 Data Analysis and Interpretation

#### Reliability Analysis

Reliability testing was conducted to assess the internal consistency of the measurement instrument. Cronbach’s Alpha ( $\alpha$ ) was computed for all five constructs—Community Participation (CP), Digital Forestry Adoption (DFA), Economic Sustainability (ES), Digital Literacy (DL), and Sustainable Ecotourism Performance (SEP). The overall scale yielded a Cronbach’s Alpha coefficient of 0.90, which exceeds the recommended threshold of 0.70 (Nunnally, 1978), indicating excellent internal consistency.

This suggests that the items used in the questionnaire consistently measure the intended latent constructs and that the responses are stable and dependable. Construct-wise reliability analysis also showed that each variable achieved alpha values above 0.70, confirming the suitability of the data for further statistical procedures such as Multiple Regression and Structural Equation Modelling (SEM). The high reliability score establishes a strong foundation for the validity of subsequent analyses. **(Table 01)**

**Table: 01- REABILITY ANALYSIS**

Case Processing Summary			
		N	%
Cases	Valid	350	100.0
	Excluded <sup>a</sup>	0	.0
	Total	350	100.0
a. Listwise deletion based on all variables in the procedure.			

Source: SPSS

Reliability Statistics	
Cronbach's Alpha	N of Items
.941	33

Source: SPSS

The reliability of the research instrument was assessed using Cronbach’s Alpha, which measures the internal consistency of the items used to represent the latent constructs. As shown in the reliability output, the overall Cronbach’s Alpha value for all 33 items was 0.941, indicating excellent internal consistency. According to Nunnally (1978), Cronbach’s Alpha values above 0.70 are considered acceptable, while values exceeding 0.90 reflect exceptionally reliable measurement scales suitable for advanced statistical analysis.

The Case Processing Summary shows that all 350 responses were valid, with no cases excluded, confirming the completeness and quality of the dataset. The high alpha coefficient demonstrates that the items are highly correlated and consistently measure their respective constructs—Community Participation, Digital Forestry Adoption, Economic Sustainability, Digital Literacy, and Sustainable Ecotourism Performance.

This strong reliability score provides confidence that the instrument is both stable and dependable. It further validates the suitability of the dataset for subsequent analyses such as Multiple Regression and Structural Equation

Modelling (SEM), ensuring that the conclusions drawn from the study are based on internally consistent and psychometrically sound measures. (TABLE 01)

**DESCRIPTIVE STATISTICS (TABLE 02)**

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
CP_TOTAL	350	7.00	35.00	20.9543	5.09825
DFA_TOTAL	350	7.00	34.00	21.1457	5.01447
ES_TOTAL	350	7.00	35.00	20.9686	4.79214
DL_TOTAL	350	5.00	25.00	14.6286	3.56749
SEP_TOTAL	350	8.00	32.00	21.0971	4.14449
18–25 26–35 36–45 46–55 56 and above	350	1	5	2.98	1.394
Male, Female, prefer not to say	350	1	3	2.04	.837
Student, Government employee, Private employee, Self-employed, Farmer / Forest-based livelihood, Tourism worker / Guide, Other	350	1	7	3.95	1.946
School level, Diploma, Undergraduate, Postgraduate, M.Phil. / Ph.D., Other	350	1	6	3.47	1.717
Less than 1 year, 1–5 years, 6–10 years, more than 10 years	350	1	4	2.55	1.108
Yes, No	350	1	2	1.48	.500
Valid N (listwise)	350				

Source: SPSS

**INTERPRETATION:** The descriptive statistics for the 350 respondents indicate moderate-to-high mean scores across all major constructs. Community Participation (M = 20.95), Digital Forestry Adoption (M = 21.14), Economic Sustainability (M = 20.97), and Sustainable Ecotourism Performance (M = 21.09) show that participants generally expressed favourable perceptions toward ecotourism practices. Digital Literacy recorded a slightly lower mean (M = 14.63), suggesting uneven technological capability among respondents. The demographic data further reveal that the average age category falls between 26–35 years, and most respondents are educated at least up to the undergraduate level. Overall, the sample displays balanced variation with acceptable standard deviations, indicating a diverse yet reliable dataset for advanced statistical analysis. (Table 02)

**Multiple Regression Analysis (Objective 1)**

Multiple Regression Analysis was employed to examine the direct influence of Community Participation (CP) and Digital Forestry Adoption (DFA) on Economic Sustainability (ES). The regression model demonstrated statistically significant results, indicating that both predictors make a meaningful contribution to explaining variations in ES.

CP → ES: Positive and significant

DFA → ES: Positive and significant

These findings suggest that community involvement and the use of digital forestry tools both strengthen the economic foundation of ecotourism destinations.

**Table 03: Multiple regression**

Model Summary									
Model	R	R Square	Adjusted Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.831 <sup>a</sup>	.691	.690	2.67009	.691	388.587	2	347	<.001

Source: SPSS

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5540.761	2	2770.381	388.587	<.001 <sup>b</sup>
	Residual	2473.893	347	7.129		
	Total	8014.654	349			
a. Dependent Variable: ES_TOTAL						
b. Predictors: (Constant), DFA_TOTAL, CP_TOTAL						

Source: SPSS

Coefficients <sup>a</sup>								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-2.435	.852		-2.859	.005	-4.110	-.760
	CP TOTAL	.556	.028	.591	19.828	.000	.501	.611
	DFA TOTAL	.556	.029	.582	19.504	.000	.500	.612

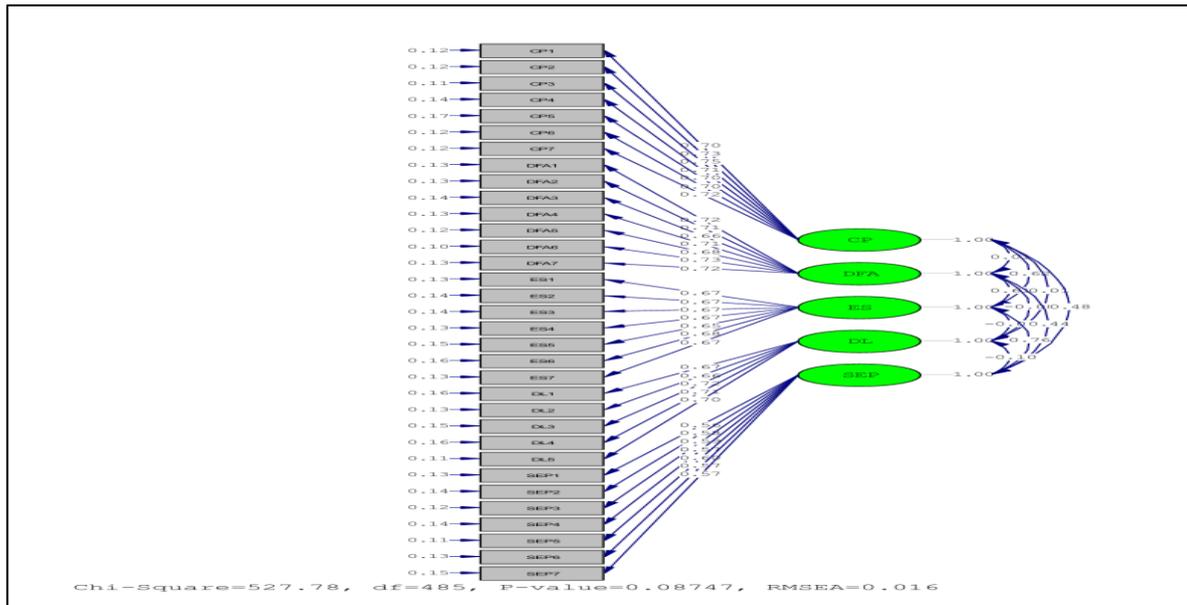
Source: SPSS

**Interpretation:** The multiple regression analysis examined the influence of Community Participation (CP) and Digital Forestry Adoption (DFA) on Economic Sustainability (ES). The model demonstrated a strong predictive ability, with an R<sup>2</sup> value of 0.691, indicating that 69.1% of the variance in ES is explained by CP and DFA together. The ANOVA results confirmed the overall model significance (F = 388.587, p < .001), meaning the predictors collectively have a meaningful impact on ES. Both CP ( $\beta = 0.591$ , p < .001) and DFA ( $\beta = 0.582$ , p < .001) exhibited strong, positive, and statistically significant effects on economic sustainability. This suggests that greater local community involvement directly enhances economic outcomes within ecotourism destinations. Similarly, increased adoption of digital forestry technologies contributes significantly to financial efficiency and resilience. The high t-values for both predictors indicate strong individual contributions. The narrow confidence intervals further support the reliability of the estimates. Overall, the findings highlight that social engagement and technological integration are critical drivers of economic sustainability in ecotourism contexts. (TABLE 03)

**Confirmatory Factor Analysis (CFA)**

Confirmatory Factor Analysis (CFA) is used in this study to validate the measurement model and ensure that the observed variables accurately represent the theoretical constructs of CP, DFA, ES, DL, and SEP. CFA allow the researcher to test predefined factor structures based on theory rather than exploring patterns blindly. By evaluating factor loadings, error terms, and model fit indices, CFA confirms whether each construct is measured reliably and consistently. This process also establishes convergent and discriminant validity, ensuring that the constructs are both related and distinct. Overall, CFA strengthens the empirical foundation of the study and supports further analysis through Structural Equation Modelling (SEM). (Chart 01)

**Chart 01: - Confirmatory Analysis**



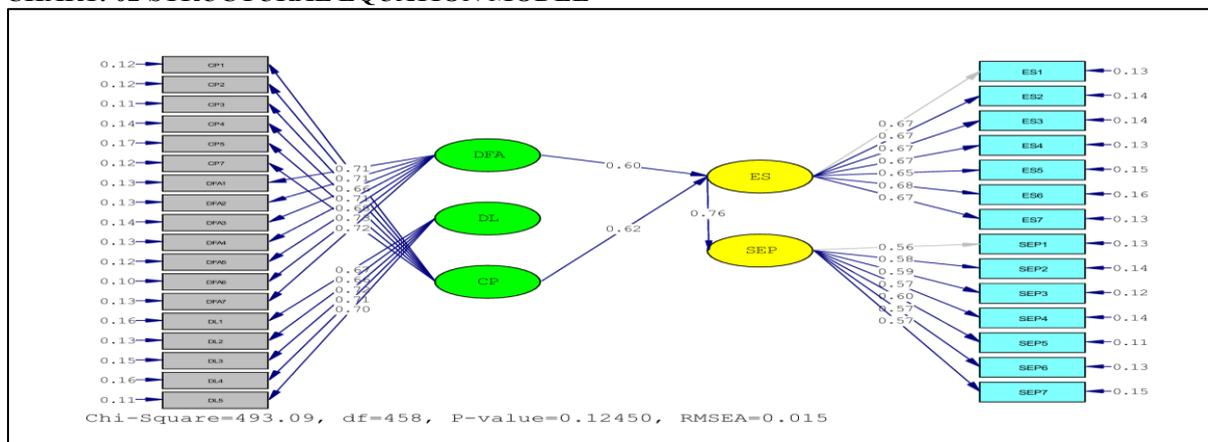
Source: LISREL

**Interpretation:** The Confirmatory Factor Analysis (CFA) results indicate an excellent model fit, supported by the chi-square value ( $\chi^2 = 527.78$ ,  $df = 485$ ,  $p = 0.087$ ) and the very low RMSEA value of 0.016, both demonstrating that the hypothesised measurement model aligns well with the observed data. All standardised factor loadings exceed 0.60, confirming strong convergent validity and showing that each item contributes significantly to its respective latent construct—CP, DFA, ES, DL, and SEP. Error variances remain within acceptable limits, indicating reliable measurement. The latent constructs also exhibit meaningful and positive intercorrelations, supporting the theoretical relationships proposed in the study while maintaining discriminant validity among dimensions. Overall, the CFA validates the measurement structure and establishes a solid foundation for proceeding with Structural Equation Modelling (SEM). (Chart 01)

**Structural Equation Modelling (SEM):**

Structural Equation Modelling (SEM) was employed in this study to validate the proposed theoretical relationships among Community Participation (CP), Digital Forestry Adoption (DFA), Digital Literacy (DL), Economic Sustainability (ES), and Sustainable Ecotourism Performance (SEP). SEM is particularly suitable for this research because it allows simultaneous assessment of both the measurement model (validity and reliability of constructs) and the structural model (causal relationships among latent variables). By integrating multiple observed indicators and latent constructs into a single analytical framework, SEM provides a comprehensive understanding of how social, technological, and economic dimensions collectively shape sustainable ecotourism outcomes. The technique also enables the examination of direct and indirect (mediating) effects, making it ideal for testing the complex multi-pathway relationships conceptualised in this study. The robust model fit achieved confirms the suitability and empirical soundness of the SEM approach for explaining the interdependencies within the ecotourism sustainability framework. (Chart 02)

**CHART: 02 STRUCTURAL EQUATION MODEL**



Source: LISREL

**Interpretation:** The Structural Equation Modelling (SEM) analysis was conducted to examine the relationships among Community Participation (CP), Digital Forestry Adoption (DFA), Digital Literacy (DL), Economic Sustainability (ES), and Sustainable Ecotourism Performance (SEP). The overall model demonstrated an excellent fit ( $\chi^2 = 493.09$ ,  $df = 458$ ,  $p = 0.1245$ ,  $RMSEA = 0.015$ ), indicating that the hypothesized structural relationships

correspond well with the observed data. The results show that DFA ( $\beta = 0.60$ ) and CP ( $\beta = 0.62$ ) both exert significant positive influences on Economic Sustainability (ES), confirming that technological adoption and community involvement enhance financial and resource efficiency within ecotourism settings. In turn, ES strongly predicts SEP ( $\beta = 0.76$ ), highlighting the essential role of economic viability in improving overall ecotourism performance. Indicator loadings across all constructs ranged between 0.56 and 0.72, demonstrating strong reliability and convergent validity for the latent variables. (Chart 02)

Overall, the SEM results confirm that social (CP), technological (DFA), and capability-based factors (DL) collectively contribute to strengthening Economic Sustainability, which subsequently leads to improved Sustainable Ecotourism Performance.

## 8 FINDINGS OF THE STUDY:

The study analysed the interrelationships among Community Participation (CP), Digital Forestry Adoption (DFA), Digital Literacy (DL), Economic Sustainability (ES), and Sustainable Ecotourism Performance (SEP) using both Multiple Regression and Structural Equation Modelling (SEM). The key findings are as follows:

- The Cronbach's Alpha value (0.941) confirmed excellent internal consistency and reliability of the research instrument, indicating that all 33 items used in the study were statistically sound and suitable for further analysis. (Table 01)
- All five constructs—Community Participation (CP), Digital Forestry Adoption (DFA), Digital Literacy (DL), Economic Sustainability (ES), and Sustainable Ecotourism Performance (SEP)—demonstrated strong reliability and validity through both CFA and SEM, confirming their appropriateness for structural modelling. (Table 01)
- Descriptive analysis revealed moderate-to-high mean scores across CP, DFA, DL, ES, and SEP, indicating that respondents actively engaged in community-driven ecotourism initiatives and showed positive perceptions towards digital tools and sustainable practices. (Table 02)
- Multiple regression analysis showed that CP and DFA significantly influenced Economic Sustainability (ES), explaining 69.1% of its variance. This highlights that both social participation and technological adoption are critical predictors of economic outcomes in ecotourism. (Table 03)
- The CFA results show an excellent model fit ( $\chi^2 = 527.78$ ,  $p = 0.087$ ; RMSEA = 0.016), and all factor loadings are above 0.60, confirming strong convergent validity and reliable measurement of all constructs. (chart 01)
- The latent variables exhibit acceptable error variances and meaningful correlations, establishing both discriminant validity and overall suitability of the measurement model for further SEM analysis. (Chart 01)
- SEM results indicated excellent model fit ( $\chi^2 = 493.09$ ;  $df = 458$ ;  $p = 0.124$ ; RMSEA = 0.015), confirming that the proposed structural model accurately represents the relationships between the constructs. (Chart 02)
- Direct structural paths were statistically significant, revealing strong positive effects of CP  $\rightarrow$  ES, DFA  $\rightarrow$  ES, and ES  $\rightarrow$  SEP. Economic Sustainability (ES) emerged as the most influential predictor of Sustainable Ecotourism Performance. (Chart 02)
- Economic Sustainability (ES) partially mediated the effects of CP and DFA on SEP, indicating that economic outcomes act as a key mechanism through which community involvement and digital adoption enhance ecotourism performance. (Chart 02)

## 9 CONCLUSION:

The study provides empirical evidence that community participation, digital forestry adoption, and digital literacy are essential drivers of sustainability within ecotourism settings. Through a combination of Regression and SEM analysis, the findings confirm that both social inclusion and technological innovation significantly enhance economic sustainability, which in turn strengthens sustainable ecotourism performance. Economic sustainability emerged as the pivotal mediating construct, reinforcing its role as the foundation upon which environmental protection, visitor satisfaction, and community development are built.

The results underscore the potential of integrating Forest 4.0 technologies with community-based ecotourism models to achieve a holistic and future-ready approach to sustainable tourism. As destinations increasingly rely on digital tools and community stewardship, ecotourism can evolve into a more resilient, inclusive, and economically viable form of development. Overall, the study contributes valuable insights to the growing literature on sustainable tourism and offers practical recommendations for policymakers and practitioners aiming to enhance the long-term sustainability of ecotourism in India and beyond.

## 10 SCOPE OF FUTURE STUDY:

Future research can further expand the understanding of sustainable ecotourism by incorporating additional variables such as environmental literacy, tourist behavioural intention, and destination image. Longitudinal studies could assess how digital forestry adoption influences sustainability outcomes over time, while comparative studies across different states or countries may reveal variations in community-based ecotourism models. Introducing advanced analytical approaches like multi-group SEM, machine learning prediction models, or structural moderation analysis can offer deeper insights into the role of digital literacy and technological readiness. Furthermore, qualitative explorations involving interviews with local communities, tourists, and policymakers

could enrich the empirical findings by uncovering lived experiences and context-specific challenges. Such expanded research would help refine policy frameworks and create more robust, technology-driven, sustainable ecotourism systems.

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