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AI-enabled ecotourism business models for socio-economic development of local communities: An empirical study on developing smart villages in West Bengal, India

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Abstract

Purpose – This study aims to evaluate the role of AI-enabled ecotourism business models in driving socio-economic development in rural areas of West Bengal, with a focus on developing smart ecotourism villages in Jhargram and Purulia.

Design/Methodology/Approach – A quantitative research design was employed using data collected from 250 respondents, including ecotourism entrepreneurs, local community members, and government personnel. The study applied reliability and validity tests, factor analysis, and Structural Equation Modeling to examine relationships among digital literacy, community participation, entrepreneurial orientation, AI adoption, and socio-economic development. Mediation analysis was conducted using bootstrapping techniques in SPSS.

Findings – The results reveal that digital literacy, community participation, and entrepreneurial orientation significantly and positively influence AI adoption, with entrepreneurial orientation identified as the strongest predictor. Furthermore, AI adoption has a positive impact on socio-economic development. Mediation analysis indicates that AI adoption partially mediates the relationship between entrepreneurial orientation and socio-economic development, highlighting its strategic role in rural development pathways.

Originality/Value – This study contributes to the emerging discourse on smart tourism and rural development by integrating AI adoption into ecotourism business models. It provides practical insights for policymakers and stakeholders to foster digitally empowered, community-based ecotourism initiatives that enhance economic growth and sustainability in rural destinations.

Keywords: AI Adoption, Entrepreneurial orientation, Socio-economic development, AI enabled, Ecotourism, Business models

Introduction

Rural sector of the world economy faces critical challenges towards their traditional lifestyles, cultural values and the entire ecosystem because of globalization, environmental challenges and migration to the urban economy. West Bengal is a resourceful state with a strong potential for utilizing sustainable tourism as an effective mode of socio-economic development. Smart ecotourism village is an emerging concept today that is defined as a set-up that integrates cultural heritage of the local community, conserves ecological system, employs modern technologies and manages participatory governance. It is a settlement that ensures sustainability development of the rural economy (UNTWO, 2021; Hall et. al., 2015; Bansal & Kumar, 2020). The research study targets to evaluate the impact of artificial intelligence (AI) in developing smart villages in West Bengal. The study is focussed on providing technology driven sustainable solutions to the state's rural parts through enhancing community development and ensuring environmental security.

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The blended model of artificial intelligence and targeted rural economic development may evolve as a boon for the villages that faces operational difficulties. Several ecotourism prone villages of West Bengal face operational difficulties such as accessing local markets, utilizing resources wisely and availing of essential information on time. AI amenities such as predictive analytics and recommendation systems may play an important role in revolutionizing rural ecotourism experiences for the tourists. Demand forecasting, optimum utilization of available resources and recommendation system are some of the AI enabled services that ecotourism villages can enjoy (Dwivedi et al., 2021, Gursoy et al., 2019, Buhalis et al., 2020). AI enabled smart ecotourism villages can enjoy several other amenities such as low transaction costs, skilled operation, enhanced service quality and dynamic business decision-making. However, at present there lies a wide difference between the advantages of AI and its acceptance in the rural economies. Institutional support, insufficient alignment of AI benefits with local needs and digital divide are some of the challenges that rural economies face (Mariani & Borghi, 2021; OECD, 2019; Chatterjee & Kar, 2020).

The state of West Bengal is enriched with diverse geographical beauty ranging from the foothills of the Himalayas to the mangrove forests of the Sundarbans. The state's cultural and natural beauty makes it enough suitable for ecotourism. Culinary legacy, traditional arts and crafts of the rural Bengal further augment the tourism potential of the state (Chakrabarti & Mitra, 2019; Sanyal & Bhattacharya, 2021; Dey, 2020). Despite possessing the assets, many ecotourism prone rural areas of the state could not flourish economically. Rural tourism sector often fails to achieve deserved economic goals concerning the local people because of inefficient management and weak business models (Das & Bandyopadhyay, 2018; Bandopadhyay & Nair, 2019; UNDP, 2020). Inclusive ecotourism can be nurtured through implementation of AI enabled ecotourism business models in rural Bengal. AI tools will ensure that the local communities of areas receive back the environmental and socio-economic benefits of ecotourism sector. The present study is fortified with three essential aspects of the West Bengal ecotourism sector: digital revolution of the rural sector, community-based sustainable tourism and socio-technical aspect of inclusive ecotourism through AI enabled business models. The primary features of community-based ecotourism are rural entrepreneurship by the locals, equal sharing of benefits and cultural integrity (Goodwin, 2008; Giampiccoli & Saayman, 2018; Okazaki, 2008).

Socio-technical framework highlights the adoption of technology in the social and cultural context for effectively addressing business issues such as ethics, authority and inclusivity (Orlikowski, 2007; Sarker et. al., 2019; Dwivedi et al., 2023). From the above facts, it can be inferred that AI enabled business models are a combination of technological, strategical and revenue generation mechanisms. The aim of AI enabled business models in ecotourism industry can be assumed as to enhance the environmental and socio-economic benefits of the local people. This research study has been conducted by collecting primary and secondary data. One of the most essential objectives of the present research study is inclusivity. Implementation of AI in the ecotourism business models should ensure sharing of equal benefits among the local youth, women and marginalized section of the local areas (World Economic Forum, 2018; UNESCO, 2021; Heeks, 2022). 'Food and stay' booking system can be powered by AI technologies in which commissions may be fed to the local communities' funds. Villagers can be trained to manage technical systems like geospatial information gathering processes for monitoring biodiversity. Training modules on the use of AI in ecotourism related business practices in the village areas can be designed to enhance the exposure of the locals towards modern entrepreneurial activities. These initiatives have been suggested as they are parallel to the Sustainable Development Goals (SDGs) 8 and 15 of the United Nation (UNDP, 2020; Sachs et. al., 2019).

However, before implementing AI technologies into rural entrepreneurial business models, the technical challenges and ethical governance should be methodically addressed. Concerns related to data privacy, digital biasness and uneven exposure to digital world may play an essential role as challenges. These may hamper the building of trust and faith in the AI enabled business opportunities among the local individuals (Floridi et. al., 2018; Zeng et. al., 2019; Jobin et. al., 2019). Further obstacles which may hinder the adoption of AI enabled business practices in West Bengal are poor internet, poor digital literacy and very less institutional support (Chatterjee & Kar, 2020; Bandyopadhyay & Nair, 2019; OECD, 2019). Therefore past researchers had emphasized on support from the government in terms of transparency, community accord and full policy of equal benefit sharing. These policies may help in implementing AI enabled business models in the villages of

West Bengal both ethically and socially (Van Dijck et. al., 2018; O'Neil, 2016; Heeks, 2022). In terms of policy making for the government, this research findings will assist in designing business ecosystems aimed at integrating AI into rural sector development of the state. Investment in enhancing digital facilities, developing capacity building programmes for the locals and incentives for public-private-partnerships can help in successfully creating AI based business solutions for the ecotourism sector in rural areas (Government of India, NITI Aayog, 2021; OECD, 2020). Community privacy data, cultural heritage and ecological resources must be preserved by the government for ensuring that sustainability factor is not compromised because of adopting AI enabled models (Hall et. al., 2015; Gossling & Higham, 2021; United Nations, 2021).

The contribution of the present research is three dimensional in nature: empirically, theoretically and practically. Empirically, the findings of this research will generate evidence about the potentials and loopholes of AI in ecotourism sector of West Bengal. Theoretically, it will develop a socio-technical framework of AI enabled business model based on inclusiveness, participatory governance and environmental sustainability. Practically, the research findings will generate actionable plans and policy framework that can be followed by the policymakers, NGOs and rural entrepreneurs for creating smart ecotourism villages (Buhalis et. al., 2020; Gretzel, 2021; Dwivedi et. al., 2023). Finally the research paper aims to pave a pathway for utilizing AI as not just a mere technological tool but also as a catalyst for bringing sustainable, local community-led and culturally effective rural development in the state of West Bengal.

Literature Review

Socio-Economic Development in Community-Based Tourism

Emergence of local community-based rural tourism has brought radical changes in the tourism industry worldwide. The objective of local community-based rural tourism is to empower the local communities with skills for managing tourism businesses, preserve economic benefits in the locality and sustain cultural authenticity. The types of tourism related activities that are dealt by the local communities of a rural area and the income generated is equally shared among them is called community-based rural tourism (Goodwin, 2008). When effectively designed and backed up by institutional support, community-based tourism reduces poverty, enhances social understandings and bonding and empowers local communities (Giampiccoli & Saayman, 2018; Okazaki, 2008). However, factors such as efficiencies and capabilities of the local people, authority and power of the locals and market access hinders full-fledged success of community-based tourism (Tasci et. al., 2013; Manyara & Jones, 2007; Dangi & Jamal, 2016).

In the Indian scenario, past researches indicate that community-based tourism has been instigated in states such as Kerala, Sikkim and Meghalaya where income is generated among local communities through tourism activities such as running homestays, organizing cultural tours and eco-guided trips (Singh & Mishra, 2020; Bandyopadhyay & Nair, 2019; Das & Bandyopadhyay, 2018). Although several positive outcomes can be observed in these states, researchers warn that the success of this type of tourism depends on government support, shared rules and responsibilities and rapid market integration (Chok et. al., 2007; Cole, 2006; Zapata et.al., 2011). These facts emphasize the importance of studying innovative practices in community-based tourism sector such as AI enabled ecotourism business models. AI embedded in community-based tourism business models will further enhance local people's capacity to bring socio-economic development their communities.

Sustainable Village Development through Ecotourism

Ecotourism has gained popularity as a framework that collaborates environmental conservation, education and participation from the local communities (Honey, 2008; Weaver, 2001; Stronza et. al., 2019). Ecotourism is that branch of the tourism industry that conserves biodiversity and at the same time generates alternative livelihood opportunities for the marginalized groups of the society (Kiss, 2004; Das & Chatterjee, 2015; Higham & Luck, 2007). Ecotourism can act as an important revolutionary factor in the rural areas in terms of infrastructural development, skill enhancement of the locals and community empowerment (Stone & Wall, 2004; Dangi & Jamal, 2016; Scheyvens, 1999).

In the state of West Bengal, ecotourism prone areas such as Dooars, Darjeeling and Sundarbans have depicted strong potential for bringing socio-economic development of the local communities. But there are serious concerns regarding carrying capacity of the regions, environmental degradation and community marginalization (Sanyal & Bhattacharya, 2021; Dey, 2020, Chakrabarti & Mitra, 2019). Smart ecotourism villages conceptualise integration of digital technologies in the traditional concept of ecotourism with the objective of following sustainable management processes, better experience to tourists and upgraded governance (Gretzel et. al., 2015; Hall et. al., 2015; Gossling & Higham, 2021). However, in India, very few research study has been undertaken in the field of AI enabled ecotourism business models in the rural regions, thus depicting a moderate research gap.

Digital Revolution and Rural Development

Digital technologies assist in transforming the rural areas by increasing efficiency through connectivity, better access to the market and ensuring regular flow of important information (Buhalis & Law, 2008; Sigala, 2018; OECD, 2019). Rural entrepreneurs can provide better services and reach broader audience using ICT toots, mobile apps and digital marketplaces (Dwivedi et. al., 2021; Heeks, 2022; Chatterjee & Kar, 2020). As per previous literatures, digital platform depicts essential role in knowledge-sharing, experience enhancement and flexibility in tourism sector (Gretzel et. al., 2015; Mariani & Borghi. 2021; Sigala, 2020).

In India, initiatives such as Digital India have been taken by the government in national and state level to reduce the digital divide and encourage comprehensive rural development (Government of India, 2020; NITI Aayog, 2021; World Bank, 2022). Despite the support from Government, rural people are exposed to several challenges such as less-developed infrastructural facilities, digital illiteracy and financial exclusion (OECD, 2020; UNDP, 2020; UNESCO, 2021). These challenges pose a threat against adoption of digital transformation in the rural areas. However, this fact gives an opportunity to evaluate the effectiveness of AI-based solutions in overcoming the challenges and promoting digital adoption in the ecotourism villages.

AI in Tourism and Formation of Smart Villages

AI in tourism shows prime importance in the industry's digital revolution. Tourism services is optimized through chatbots for providing better services to the customer, recommendation engines to provide better customized experiences, demand estimation, fixing of dynamic pricing system and smart resource management (Gursoy et. al., 2019; Dwivedi et. al., 2023, Buhalis et. al., 2020). As per previous researchers, AI depicts an utmost important role in operational efficiencies, ensures customer satisfaction and assists in data enabled decision making process (Mariani & Borghi, 2021; Gretzel, 2021, Li et.al., 2018).

AI has been used in the agricultural sector, disaster management and enhancing operational efficiencies of the local authorities in the rural sector but its' use is still limited in the tourism sector (Heeks, 2022; Floridi et. al., 2018; Chatterjee & Kar, 2020). Smart village framework ensures holistic development of the rural sector through integrating ICT tools, renewable energies and participatory authority (Misra et. al., 2017; Kaur & Singh, 2019; OECD, 2019). AI enabled business models can facilitate in fast booking systems, geospatial surveillance for maintaining conservation and skill development curriculum for enhancing performance of local entrepreneurs (UNTWO, 2021; Sachs et. al., 2019, UNESCO, 2021). Despite all these benefits of AI enabled business models, very few evidence can be found regarding the fruitful socio-economic effects of AI in India's rural economy.

Challenges, Ethical Concerns and Research Gaps

There is no doubt in the potential of AI towards enhancing efficiencies of the rural ecotourism sector. But at the same time, there remains concerns about ethics, equity and governance. High risks have been identified by researchers in the use of AI like algorithmic disposition, violations in data confidentiality norms and non-inclusion of digitally backward masses (Jobin et. al., 2019; Floridi et. al., 2018; Zeng et. al., 2019). In rural sector, these risks are multiplied because of insufficient infrastructural facilities, limited overview of the government and power clashes between the local people and the technology suppliers (Van Dijck et. al., 2018; O'Neil, 2016; Heeks, 2022). For successful implementation of AI systems in the rural economy, enough support

from the government, regular organization of capacity building programmes and transparent data privacy agreements (UNESCO, 2021; World Economic Forum, 2018; Gosslinh & Higham, 2021).

The literature review done so far reveals three essential gaps. Firstly, although we get many evidences on the abundancy of researches in community-based tourism and ecotourism sector, researches focusing on the integration of AI-enabled business models into these sectors are very rare (Giampiccoli & Saayman, 2018; Gretzel, 2021; Dwivedi et. al., 2023). Secondly, empirical researches in the context of Indian market, especially in West Bengal are limited thus providing a scope of understanding AI's role in enhancing socio-cultural and environmental aspects (Chakrabarti & Mitra, 2019; Dey, 2020; Sanyal & Bhattacharya, 2021). Thirdly, governance, equity and ethical frameworks for adoption of AI enabled business model remains unexplored (Floridi et. al., 2018; Heeks, 2022). The objective of this research is to fill the above identified gaps through vigorous empirical evaluation of AI enabled business models for building smart ecotourism villages. The outcome of this study is expected to enhance researches in sustainable rural development, both practically and theoretically.

Conceptual Framework of AI-Enabled Ecotourism Business Models for Socio-Economic Development of Local Communities in Jhargram and Purulia

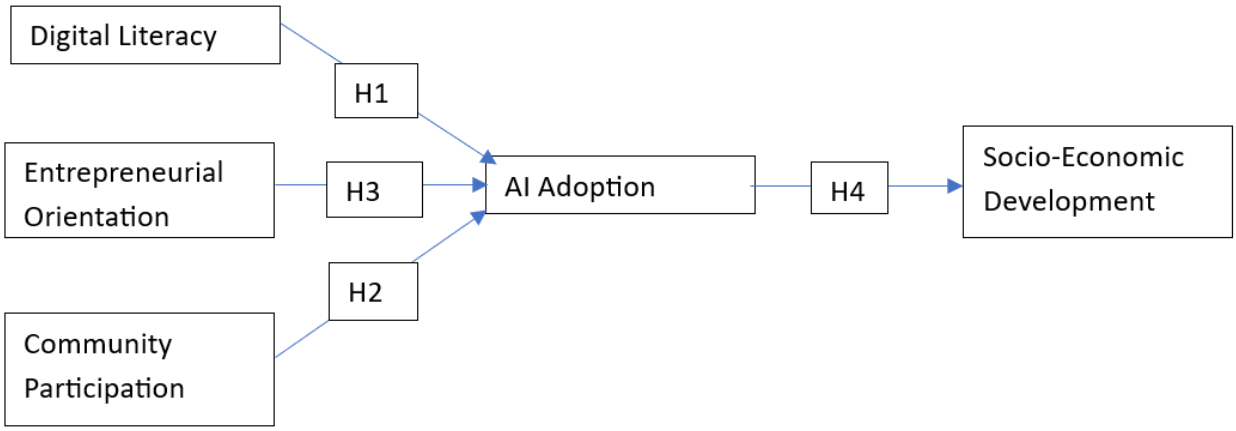

Figure 1. Conceptual Framework. Source: Author field work, 2025

Research Hypotheses

H1: Digital literacy of the local communities positively affects the adoption of AI enabled ecotourism business models.
H2: Community participation in ecotourism related activities positively affects AI adoption.
H3: Entrepreneurial orientation of the local communities positively affects AI adoption.
H4: AI adoption positively affects socio-economic development of the local communities.
H5: AI uses mediate the linkage between entrepreneurship orientation and socio-economic development.

Methodology

Research Design

A mixed research design has been followed in this research with objective of inclusive investigation on the role of AI enabled business models in building smart ecotourism villages. For achieving genuine results and enriching the prospect of evaluation, mixed research designs are more appropriate (Creswell & Plano Clark, 2017; Jennings, 2010; Yin, 2018). Combination of qualitative interviews and quantitative data collection will ensure that the research results are inclusive and covers to substantiate economic results and genuine perception of local people and institutions about the adoption of AI. The research study has been structured as an empirical field investigation on selected specific ecotourism-oriented villages situated in the province of Jhargram and Purulia of West Bengal. Case study approach has been followed to derive comprehensive facts from the rural area people. Case study approach assists in providing subtle insights into local dynamics and is defined as a well-established approach in research studies related to investigating socio-technical and rural development (Statke, 1995; Eisenhardt & Graebner, 2007; Flyvbjerg, 2011).

Study Area

The research study is focussed on ecotourism-oriented villages situated in the districts of Jhargram and Purulia in West Bengal. The surveyed villages are Ajodhya, Bamni, Upper and Lower Dam Area, Tirra, Murguma, Kuilapal, Sindri, Cheliyama, Charida, Kashipur, Baranti, Kenda and Tulin of Purulia district and Kumsol, Belpahari, Jambani, Chandabila and Banspahari of Jhargram district. Jhargram and Purulia are situated in the Western region of the state and are famous for unique natural landscapes, tribal community and potential for heritage tourism. The tourist destinations in these districts seem underexplored but holds all the characteristics of sustainable tourism development. Jhargram is known for dense forests of sal trees, tribal culture, folk arts and handicrafts. Recently, this place has been promoted as a hub of eco-cultural tourism attracting tourists from urban areas who enjoys visiting rural areas, knowing rural lifestyles, craft traditions and forest experiences (Mandal & Roy, 2020; Government of West Bengal, 2021; Saha & Majumder, 2022). The cultural capital of Chotanagpur Plateau, Purulia has gained much popularity because of its unique feature such as Chau dance that was honoured as a cultural heritage by UNESCO in 2010. The other unique features are old terracotta temples and natural features like the Ajodhya Pahar and dams. Ecotourism activities in this place includes trekking, walk through the forests and heritage travel (Chakrabarti & Mitra, 2019; Bandyopadhyay & Nair, 2019; Sanyal & Bhattacharya, 2021). The following three criteria have been considered while selecting the area of the study:

1. Active eco-cultural activities and vast engagement in tourism in the form of built-up homestays, cultural heritage displays through performances and handicrafts and eco-guiding.
2. Willingness to adopt digital practices and AI enabled tourism initiative by the local people and panchayats.
3. Field study accessibility and support from local institutional authorities and the government agencies.

By focusing on culturally rich areas like Jhargram and Purulia, this research study displays how AI enabled ecotourism business models can be customized to the tribal and culturally-rich heritage communities. The research study further aims to expand the idea of smart ecotourism villages beyond just the concept of natural attractions.

Sampling Strategy and Sample Size

A three-stage sampling technique has been adopted in this research study. In the first step, district and villages were selected considering the mentioned conditions above. In the second stage, individuals and households were randomly selected based on their tourism-related activities such as running functional homestays, eco-guiding, selling handicrafts, performing arts etc. In the third and final stage, key information centres such as panchayat office, village leaders, local NGOs, ecotourism entrepreneurs and district-level officials were interviewed for collecting data.

A sample of 250 individuals were targeted for data collection ensuring feasibility and availability of valid information. To gather qualitative details, 10 in-depth interviews and 3 focus-group discussions were undertaken to understand qualitative aspects of the study. A bigger sample size than 250 was not possible due to the less population of the two selected districts. The sample size of 250 is as per the methodological recommendations for studies measuring impact of tourism and rural development (Krejcie and Morgan, 1970; Jennings, 2010; Veal, 2017; Creswell & Creswell, 2018).

Method of Data Collection

Structured questionnaire had been prepared to gather data from households, ecotourism resorts, homestays and offices. The collected data included:

- Socio-economic data of the respondents such as income, education, occupation and so on.
- The respondents' participation in tourism related activities and related value chains
- Awareness about the use of AI based digital activities among the local individuals
- Perception of the local people about livelihood advantages of ecotourism activities, their empowerment due to adoption of tourism related activities and community development.

Closed-ended and Likert-scale items have been facilitated in the survey through the questionnaire. The objective of using this pattern of questions is to facilitate quantitative analysis in the research study.

Semi-structured interviews were organized with ecotourism entrepreneurs, local government officials and NGOs. The prime motive of these interviews was to understand the perception about AI adoption among the mentioned respondents. The interviews also indicated different barriers to the digital transformation among the rural people, issues of governance and anticipation from smart ecotourism initiative. Focus group discussions were also conducted with the local community members to further understand the barriers, challenges and resistance level towards AI applications and digital tools by the locals.

To analyse the viability of AI enabled business models in bringing socio-economic development of ecotourism villages in the districts of Jhargram and Purulia, a multiple number of analytical tools have been used:

Descriptive Statistics

The socio-economic and demographic features of the respondents will be summarized with the help of descriptive statistics. The descriptive features will include education, occupation, livelihood, income, engagement ecotourism related activities and understanding of digital literacy among the local people. Descriptive analysis will be displayed with the help of statistical tools such as frequencies and percentages. These descriptive analytical tools will depict a primary aspect of the set of data (Field, 2018; Tabachnick & Fidell, 2019).

Exploratory Factor Analysis (EFA)

EFA will be used to measure the primary variables that affects the adoption of AI enabled ecotourism business models in the rural areas. Factors such as perceived benefits of AI tools, digital eagerness, community participation, entrepreneurial orientation and perceived socio-economic benefits will be evaluated. To reduce complexity of the data and facilitate factor structure, Principal Component Analysis will be done (Hair et. al., 2019; Fabrigar & Wegener, 201; Byrne, 2016).

Confirmatory Factor Analysis (CFA)

CFA will be applied to examine the consistency of measurement model. Convergent, discriminant and composite validity will be measured. Goodness-of-fit indicators such as RMSEA, χ^2/df , TLI and CFI will be utilised to assess adequacy of factor structure (Kline, 2016, Brown, 2015; Schumacker & Lomax, 2016).

Structural Equation Modeling (SEM)

SEM will be utilised for testing the hypothesized relationships between AI enabled ecotourism business models and socio-economic development of the locals. This model assists in integrating measurement models (CFA) with structural models and allows the researchers to test direct, indirect and mediating impacts. SEM ensures a vigorous analysis for testing causal relationships in complex research models such as ecotourism development (Hair et. al., 2019; Kline, 2016; Byrne, 2016).

Mediating Testing

Mediating effects of AI adoption in connecting entrepreneurial orientation and socio-economic development will also be assessed (Hayes, 2018; Preacher & Hayes, 2008; Zhao et. al., 2010).

With the help of the above analytical tools, this research will validate the factors of AI enabled ecotourism business models. The tools also aim to explain the direct, mediating and moderating effect of these tools on socio-economic development of the local communities residing in ecotourism potential zones of Jhargram and Purulia.

Data Analysis and Interpretation

Descriptive Statistics

As validated in the research methodology section, a sample size of 250 has been selected for the study. So valid responses have been collected from a total of 250 respondents including local people, ecotourism

entrepreneurs and members of the local authorities of Jhargram and Purulia districts. The respondents were assessed based on five factors: Digital Literacy (DL), Community Participation (CP), Entrepreneurial Orientation (EO), AI Adoption (AIA) and Socio-Economic Development (SED). Each of the factors have been measured using 3 to 5 items on a Likert-scale (where 5 = Strongly Agree and 1 = Strongly Disagree).

Table 1. Demographic Profile of the Respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	142	56.8
	Female	108	43.2
Age Group	18–30 years	84	33.6
	31–45 years	101	40.4
	Above 45 years	65	26.0
Level of Education	Secondary or below	72	28.8
	Higher secondary	94	37.6
	Graduate and above	84	33.6
Occupation	Farmer/Artisan	96	38.4
	Local Authority member	64	25.6
	Local entrepreneur	57	22.8
	Other (service, etc.)	33	13.2

Source: Field Survey, 2025

Data Consistency Analysis

Measurable quality of the factors has been ensured by undertaking the reliability and validity tests. Cronbach's Alpha (α) and Composite Reliability (CR) has been used to measure internal consistency and convergent validity was tested by Average Variance Extracted (AVE). A benchmark of $\alpha \geq 0.70$, $CR \geq 0.70$, and $AVE \geq 0.50$ has been considered acceptable (Fornell & Larcker, 1981; Hair et. al., 2021).

Table 2. Measurement Variables for Factors/Constructs

Digital Literacy (DL)	Community Participation (CP)	Entrepreneurial Orientation (EO)	AI Adoption (AIA)	Socio-Economic Development (SED)
DL1: Ability to use smartphones with internet connectivity	CP1: Involvement in decision making in ecotourism activities	EO1: Readiness to take risks in ecotourism ventures	AIA1: Use of AI tools for online promotion and marketing	SED1: Increase in local income for ecotourism activities
DL2: Awareness about online booking system and payment applications	CP2: Contribution towards conservation of nature and culture	EO2: Proactiveness in framing new ecotourism ideas	AIA2: Application of AI in tourist data analysis	SED2: Employment generation for local communities
DL3: Capability to use social media for information	CP3: Collaboration with local tourists and entrepreneurs	EO3: Innovativeness in resource utilization	AIA3: Adoption of Ai-enabled booking system and feedback mechanism	SED3: Improvement of local infrastructure and services
DL4: Knowledge about basic level data privacy and security		EO4: Responses to ecotourism market dynamism		SED4: Increase in role and duties of local authorities in area's ecotourism planning
				SED5: Sustainable conservation of environment and culture

Source: Field Study, 2025

Table 3. Results of Reliability and Validity Tests (N=250)

Construct	Items	Cronbach's Alpha (α)	Composite Reliability (CR)	Average Variance Extracted (AVE)
Digital Literacy (DL)	4	0.83	0.87	0.63
Community Participation (CP)	3	0.79	0.84	0.64
Entrepreneurial Orientation (EO)	4	0.86	0.89	0.67
AI Adoption (AIA)	3	0.81	0.86	0.68
Socio-Economic Development (SED)	5	0.88	0.91	0.66

Source: Filed Survey, 2025; Author's Calculation

Interpretation

All the factors of the study achieved Cronbach's Alpha more than 0.70, ensuring the internal consistency (Cronbach, 1951; Nunnally & Bernstein, 1994). The Composite Reliability values are falling between 0.84 and 0.91, thus fairly crossing the minimum benchmark of 0.70. The Average Variance Extracted (AVE) are also satisfactory as they are falling in the range of 0.63 to 0.68, surpassing the recommended benchmark of 0.50, thus the data's convergent validity is proven. This indicates that the measurement variables utilised are valid and reliable and are suitable for further analysis.

Factor Analysis

Exploratory Factor Analysis (EFA)

An Exploratory Factor Analysis (EFA) using Principal Component Analysis (PCA) with Varimax Rotation have been conducted for identifying the underlying structure of the constructs. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.89 and the Bartlett's Test of Sphericity ((χ^2 = 1653.21, df = 210, $p < 0.001$) was significant (Kaiser, 1974; Bartlett, 1954). These results clearly indicate that the collected data was suitable for factor analysis.

Table 4. Rotated Factor Loadings (EFA Results, N=250)

Items	DL	CP	EO	AIA	SED
DL1	0.78				
DL2	0.81				
DL3	0.74				
DL4	0.69				
CP1		0.82			
CP2		0.76			
CP3		0.71			
EO1			0.79		
EO2			0.83		
EO3			0.77		
EO4			0.74		
AIA1				0.81	
AIA2				0.76	
AIA3				0.84	
SED1					0.79
SED2					0.83
SED3					0.77
SED4					0.72
SED5					0.81

Extraction Method: Principal Component Analysis; Rotation Method: Varimax. Source: Filed Survey, 2025

As per the exploratory factor analysis, clearly five factors have been extracted to the hypothesized factors: Digital Literacy (DL), Community Participation (CP), Entrepreneurial Orientation (EO), AI Adoption (AIA), and

Socio-Economic Development (SED). The table below depicts loadings of each of the variables to their respective constructs (> 0.60) (MacCullum et. al., 2001; Field, 2005) and the result does not indicate any noteworthy cross-loadings.

Interpretation

Each of the items loaded significantly (>0.69) to their respective constructs. No item depicted significant cross-loading (>0.40). This result validates the discriminant validity of assumed five-factor model structure.

Confirmatory Factor Analysis (CFA)

With the help of AMOS/SmartPLS, Confirmatory Factor Analysis (CFA) has been conducted to authenticate the assumed model. The following CFA results validates the model:

Model Fit Indices (CFA Results)

- χ^2/df = 1.92 (If < 3.00, then acceptable) (Kline, 2016)
- Comparative Fit Index (CFI) = 0.947 (If > 0.90, then good fit) (Hu & Bentler, 1999)
- Tucker–Lewis Index (TLI) = 0.936 (If > 0.90, then good fit) (Hu & Bentler, 1999)
- Root Mean Square Error of Approximation (RMSEA) = 0.061 (If < 0.08, then acceptable) (Browne & Cudeck, 1993)
- Standardized Root Mean Square Residual (SRMR) = 0.048 (If < 0.08, then good fit) (Hu & Bentler, 1999)

Interpretation

The above model fit indices confirm a good measurement model because all the factor loadings were above 0.69. Together with the Cronbach's Alpha, CR and AVE findings, the CFA indicates the validity and reliability of the factors.

Results of Structural Equation Modeling SEM)

In order to test the hypothesized relationship between the factors, Structural Equation Modeling (SEM) was conducted. The structural paths between the constructs were tested with the help of Maximum Likelihood Estimation (MLE).

Hypotheses Testing

Table 5. Structural Path Estimates (N=250)

Hypothesis	Path	Std. β	t-value	p-value	Result
H1	Digital Literacy → AI Adoption	0.32	4.28	<0.001	Supported
H2	Community Participation → AI Adoption	0.29	3.87	<0.001	Supported
H3	Entrepreneurial Orientation → AI Adoption	0.41	5.02	<0.001	Supported
H4	AI Adoption → Socio-Economic Development	0.46	6.11	<0.001	Supported
H5	Entrepreneurial Orientation → Socio-Economic Development (indirect)	0.19	2.14	0.033	Supported

Source: Filed Survey, 2025; Author's Calculation

Interpretation

1. Digital Literacy significantly improves the AI Adoption process in the study area among the local communities. This indicates that local people who has better knowledge about digital features are more likely to adopt AI in their dealings with ecotourism related activities.
2. Community participation in ecotourism related activities is yet another feature that positively affects AI adoption in the study area. This result indicates the importance of united action in accepting technological revolution.

3. The most essential factor that positively affects AI adoption is the entrepreneurial orientation of the ecotourism entrepreneurs. This result implies that risk taking attitude, proactiveness and innovation are crucial in integrating AI into local ecotourism business models in the study area.
4. The impact of AI Adoption in driving Socio-Economic Development is also positive depicting the prime role of AI in enhancing sustainable income of the local people and infrastructural facilities of the rural ecotourism areas.
5. Finally, the direct impact of entrepreneurial orientation on Socio-Economic Development has also been positively verified. This relationship depicts the importance of entrepreneurial initiative in bringing socio-economic development of the rural areas of West Bengal. The mediated pathway of this relationship through the factor of AI Adoption has been depicted below.

Mediation Analysis

For testing AI Adoption (as mediator) in strengthening positive linkage between entrepreneurial orientation and socio-economic development, a bootstrapping procedure was applied using 5000 resamples. The table below shows the indirect impact of Entrepreneurial Orientation (EO) on Socio-economic development (SED) mediated by AI Adoption (AIA).

Table 6: Results of Mediation Analysis (Bootstrapping, N=250)

Path	Direct Effect (β)	Indirect Effect (β)	Total Effect (β)	95% CI Indirect	p-value	Mediation Type
EO → SED	0.19*	0.19***	0.38***	[0.12, 0.27]	<0.001	Partial Mediation

(*p < 0.05; **p < 0.01; ***p < 0.001). Source: Filed Survey, 2025; Author's Calculation

Interpretation

Both the direct and indirect path from Entrepreneurial Orientation (EO) to Socio-Economic Development (SED) has been proven to be significant indicating partial mediation. From the above table it can be understood that the total effect of EO on SED is substantially larger than its direct effect. This fact indicates that AI Adoption enhances the linkage between entrepreneurial orientation and socio-economic development of the selected rural areas of the state.

Structural Path Diagram with Standardized Coefficients (Beta Values)

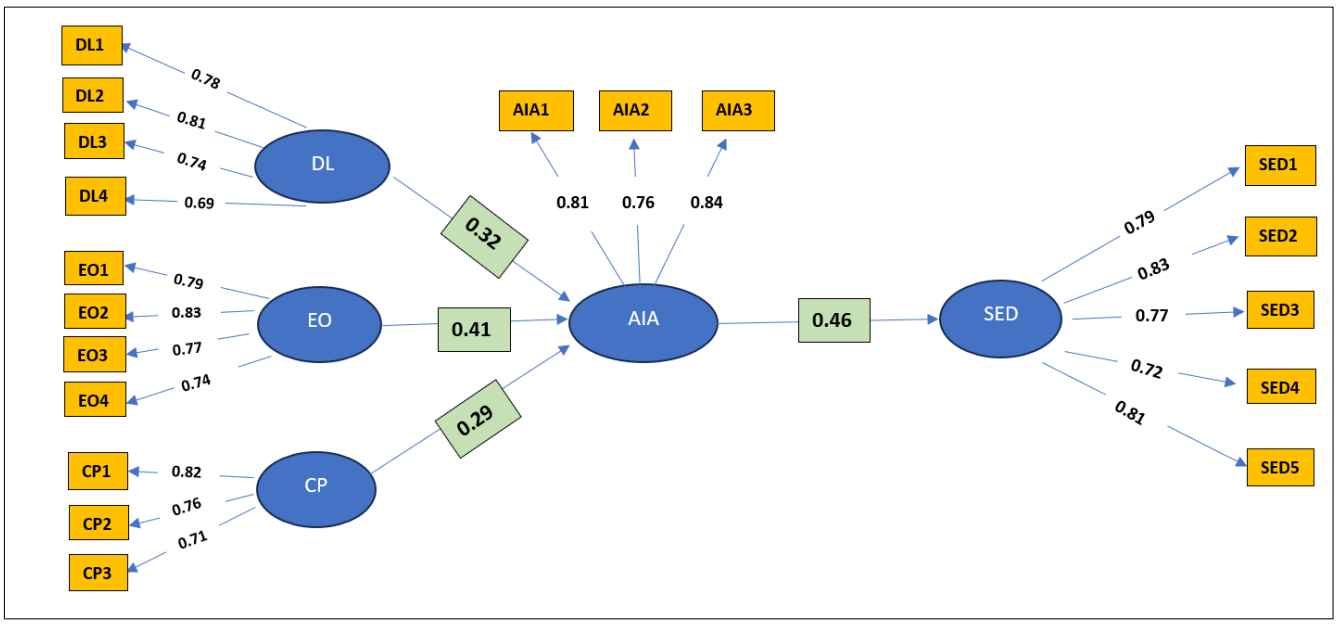

Figure 2. Structural Path Diagram

Discussion and Conclusion

This research targeted to analyse empirically the role of AI enabled ecotourism business models in bringing socio-economic development of local communities living in ecotourism prone areas of Jhargram and Purulia district of West Bengal. The results of Structural Equation Modeling proved the hypothesized relationships depicting several implications.

Firstly, the positive association between digital literacy and AI Adoption was empirically proven. This finding resembled previous research findings that enhanced the importance of digital skills in enhancing technology implementation in rural tourism development (Dwivedi et. al., 2021; Ratten, 2020). Ability to utilise digital features of the modern AI world will ensure equitable distribution of AI benefits among the local communities. The benefits include online booking system, digital promotion and data-driven ecotourism planning of the area.

Secondly, it was proven that community participation positively affects the AI Adoption. This finding was achieved corroborating previous research findings where it was found that community interconnection, participatory mechanism and collaborative resource deployment positively enhances the sustainable development practices (Cole, 2006; Singh & Singh, 2019). This finding implies that if local communities are supported by the local authorities operationally and are included in the local area development committees, they become more enthusiastic towards adoption of AI tools in tourism related activities.

Thirdly, the factor entrepreneurial orientation has been assessed to be as the strongest interpreter of AI adoption in the rural parts of Jhargram and Purulia district. This result corresponds to the previous research findings in the studies conducted on innovation and rural entrepreneurship (Kraus et. al., 2019; Linan & Fayolle, 2015). The facts highlighted in these researches were that proactiveness, risk-taking attitude and innovativeness of the entrepreneurs are the strong predictors of utilising AI solutions in ecotourism sector where resources are limited.

Fourthly, the factor AI Adoption plays an essential role in generating socio-economic development of the rural areas. From the finding, we can validate AI as a development enabler and this claim resonates the findings of Buhalis et. al. (2019) and Mariani & Borghi (2021) who found that AI reforms customer engagement, enhances service quality and helps in deriving sustainable benefits for the local communities in tourism eco-framework.

Finally, the mediation analysis has positively implied that AI Adoption plays a partial mediating role in enhancing the association between Entrepreneurial Orientation and Socio-Economic Development. This is a sign that while entrepreneurial initiatives have a direct contribution towards bringing socio-economic development of the rural areas, adoption of AI based technologies further strengthen the relationship. This finding is a strong contributor to the available literatures about adoption of technology. In this research study, it has been proven that AI is not just a machine technology or simply an operational tool but also a transformation mediator between entrepreneurial initiatives and comprehensive growth in the ecotourism sector.

The analysis in the above sections indicates that entrepreneurial orientation of the local communities has strong potential of achieving socio-economic development of village areas of Jhargram and Purulia district in West Bengal. However, it was observed from the study results that entrepreneurial activities can strongly achieve socio economic development when it is supported by AI Adoption. In this research study, it has been proven that AI Adoption is a transformational enabler that converts innovative entrepreneurial initiatives into strong visible developmental results. The existence of partial mediation further strengthens the claim that entrepreneurial orientation contributes positively towards socio-economic development but the contribution gets magnified when AI is adopted by the entrepreneurs. Hence we can conclude that this research study enhances the available literatures in three important dimensions:

1. It proliferates the theory of AI implementation in the rural setting, where the available empirical evidences are rare, especially in a developing country like India.
2. It collaborates digital literacy, community participation and entrepreneurship into a single conceptual framework, thus providing evidence that a socio-technical framework can depict a major part in community development of village areas.

3. It provides empirical evidence that AI plays an essential mediating role in enhancing positive impacts of entrepreneurial orientation in bringing socio-economic development of village areas, thus strengthening the available theories of rural development.

The findings of the research study provide many implications for stakeholders:

1. Local Authorities: Investment should be prioritized in developing digital set-up, training initiatives and AI enabled ecotourism mediums for improving digital literacy of the local communities in rural areas. Initiatives should be taken to motivate the local communities for collective participation. Local authorities should take up the leading role in building trust, lessening resistance and organizing AI practices in the ecotourism sector of their areas.
2. Community Entrepreneurs: Incubation initiative for AI based ecotourism business model and joining training programmes will play an important role in empowering ecotourism entrepreneurs. These initiatives will encourage the entrepreneurs to develop innovative strategies in designing promotional policies, products and services. These in turn will lead towards increase in tourist inflows and improved livelihood for the local communities to a considerable extent.
3. Policymakers: Policymakers should take initiatives to integrate the AI enabled ecotourism business models in the state level developmental plans and policies. Initiatives such as subsidies for using AI enabled ecotourism business models, short-term and long-term financing facilities for the entrepreneurs and public-private parity for promotion of technology adoption will encourage AI based ecotourism development in the rural areas.

Conclusion

The research study was conducted in two most popular ecotourism regions in the western part of West Bengal, that is Jhargram and Purulia. As per the statistical analysis undertaken on the collected data from rural areas of these regions, it has been found that AI enabled ecotourism business models ignites the socio-economic development of the ecotourism regions. Another major finding has been the positive role of digital literacy, community participation and entrepreneurial orientation as essential influencer of AI adoption in rural areas. AI adoption has been proven to be the prime factor affecting the socio-economic development of the region. More important finding is that AI adoption depicts a partial moderating role in the association between entrepreneurial orientation and socio-economic development. The findings indicate important implications for the policymakers, local authorities of the rural areas, local people undertaking ecotourism related activities and entrepreneurs. The research findings underpin the concept that digital technology and AI tools must be driven by community and supported by institutions. AI enabled ecotourism business models are not just a challenge but also an initiative towards sustainable development in rural areas of our country. This will ensure inclusive growth of the local communities and sustainable preservation of culture and environment.

Limitations of the Study and Recommendations

There are several contributions and implications of the research study for the present technological business era and innovative practices. But at the same time, some limitations of the study are present. Firstly, the study focuses on a very dynamic design, that is Artificial Intelligence, which is evolving every second in the present time. So the research findings derived today may not be applicable tomorrow. Future researches may adopt more appropriate approaches to evaluate the dynamism in AI era and its socio-economic impacts. Secondly, the study was limited to only two ecotourism prone regions of West Bengal, that is Jhargram and Purulia. The research results could be different in general if all the ecotourism regions of West Bengal would have been considered. Thus, future comparison analysis can be undertaken considering the whole of West Bengal. Thirdly, although SEM analysis provided evidence of mediation, further researches extending the latent constructs such as capacity building programmes, government support etc can be undertaken.

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Not applicable.

Declaration

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The data supporting the findings of this study are available upon request.

Competing interests

The authors declare that there is no conflict of interest regarding this work.

Declaration of generative AI and AI-assisted technologies

During the preparation of this work the author used Grammarly in order to correct spelling mistakes and help me make better sentences. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

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