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Enhancing Rural Tourism Development through IoT-Based Solar Internet Connectivity: A Case Study of Nanggelan Beach, Jember

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Abstract:
This study examines the implementation of an IoT-based off-grid solar internet system at Nanggelan Beach, Jember, Indonesia, as a green digital connectivity intervention designed to support sustainable rural tourism development. The objective of this research is to analyze how the integration of renewable energy, digital infrastructure, and community participation contributes to tourism promotion, local empowerment, and socio-economic opportunities in an underserved coastal destination. Employing a qualitative descriptive case study approach, the research used field observation, semi-structured interviews, evaluation forms, project documentation, and social media analysis to assess technological performance, community responses, and tourism promotion outcomes. The findings show that the solar-powered internet system provided relatively stable connectivity, supported continuous operation through renewable energy, and enabled local residents, particularly youth and small-scale tourism actors, to participate more actively in digital tourism promotion. Social media activity increased after the intervention, strengthening the online visibility of Nanggelan Beach and expanding opportunities for community-based destination branding. The study also found that digital literacy training and local involvement in system maintenance contributed to stronger community confidence, collective ownership, and emerging tourism-related economic opportunities. These results indicate that green digital connectivity can function not only as a technical infrastructure solution, but also as a socio-technical catalyst for inclusive and sustainable rural tourism transformation.

Keyword: Rural Tourism, Community Empowerment, Coastal Tourism

INTRODUCTION

Tourism has increasingly become a strategic instrument for promoting inclusive economic growth, regional diversification, and local livelihood improvement, particularly

in rural and coastal areas that possess natural landscapes, cultural assets, and community-based attractions. In developing regions, rural tourism is often positioned not merely as a recreational sector, but as a development pathway that can connect local resources with broader markets, stimulate small-scale entrepreneurship, and strengthen territorial identity.

Nevertheless, the contribution of tourism to regional development is highly dependent on the capacity of destinations to provide adequate infrastructure, reliable access, and institutional support for local participation. In many rural coastal destinations, tourism potential remains underutilized because natural attractiveness is not matched by the availability of enabling facilities that support visitor mobility, service quality, and destination promotion. This condition shows that rural tourism development must be understood as a multidimensional process involving economic, environmental, social, and infrastructural factors rather than as a sector driven solely by destination attractiveness (Gannon, 1994; Cheer, 2024; Gocer et al., 2024; Samper-Mendívil et al., 2025).

One of the most persistent problems faced by rural tourism destinations is the unequal distribution of digital infrastructure between urban and peripheral areas. Digital inequality limits the ability of remote communities to access information, participate in online markets, communicate with potential visitors, and promote tourism products through digital platforms. In the contemporary tourism economy, internet connectivity has become a basic requirement for destination competitiveness because tourists increasingly rely on digital information, online reviews, social media content, mapping applications, and real-time communication when making travel decisions.

When rural destinations lack stable connectivity, they are not only physically distant from tourism markets, but also digitally invisible within the wider tourism ecosystem. Therefore, digital exclusion should be treated as a structural development barrier that affects community participation, local entrepreneurship, and the capacity of rural destinations to compete with better-connected urban tourism areas (Akca, 2007; Erdiaw-Kwasie et al., 2016; Morris et al., 2022; Herrero-Zamorano et al., 2026).

The growing influence of digital media has further changed how tourism destinations are discovered, evaluated, and experienced by visitors. Destination visibility is no longer determined only by formal marketing agencies or conventional promotional materials, but also by user-generated content, social media storytelling, online destination images, and digital interaction among tourists, residents, and tourism actors. For rural destinations, this transformation creates opportunities to reach wider audiences at relatively low cost, but it also requires sufficient connectivity, digital literacy, and local capacity to manage online narratives.

Without digital access, community actors cannot effectively participate in destination branding, share local stories, respond to tourist expectations, or transform cultural and environmental resources into visible tourism value. This means that digital connectivity functions not only as a communication facility, but also as an entry point for strengthening destination recognition, market access, and participatory tourism promotion (Armutcu et al., 2023; Herasimovich et al., 2024; Qin et al., 2025; Vichnevetskaia, 2026).

Recent studies on smart tourism have emphasized the importance of integrating technology, data, governance, sustainability, and stakeholder collaboration in

destination development. Smart tourism technologies can support destination management through information systems, digital platforms, sensor-based monitoring, visitor data, and service innovation. However, the dominant discussion on smart tourism has often focused on urban destinations, established tourism cities, or technologically advanced areas, while remote rural and coastal destinations remain less visible in empirical debates.

At the same time, studies on renewable energy and rural electrification have generally developed in a separate research stream from tourism studies, although energy access is crucial for operating digital infrastructure in off-grid destinations. This separation indicates a research gap: limited studies have examined how smart tourism, renewable energy, and community empowerment can be integrated into one practical intervention for sustainable rural tourism transformation (Kontogianni & Alepis, 2020; Sorokina et al., 2022; Cerdá-Mansilla et al., 2024; Zhang et al., 2024).

Table 1. Research Positioning and Gap in Green Digital Connectivity for Rural Tourism Development

No.	Main Research Stream	Dominant Focus in Previous Studies	Limitation in Existing Literature	Position of This Study
1	Rural tourism development	Local economy, destination attractiveness, livelihood diversification, and community-based tourism	Limited attention to digital infrastructure as a foundation of rural tourism competitiveness	Examines digital connectivity as a key enabler of rural coastal tourism transformation
2	Smart tourism	Technology, data, digital services, and smart destination management	Frequently focused on urban or well-developed destinations	Applies smart tourism thinking to a remote coastal destination with weak infrastructure
3	Renewable energy and rural electrification	Energy access, off-grid systems, solar power, and rural development	Often discussed separately from tourism promotion and community empowerment	Connects off-grid solar energy with tourism digitalization and local participation
4	Digital tourism promotion	Social media, destination branding, online visibility, and tourist behavior	Less emphasis on infrastructure constraints in underserved destinations	Explores how internet access can improve destination visibility and community-led promotion

No.	Main Research Stream	Dominant Focus in Previous Studies	Limitation in Existing Literature	Position of This Study
5	Community empowerment	Local participation, capacity building, and community-based development	Limited integration with digital infrastructure and renewable energy intervention	Positions local residents as active actors in green digital tourism development

Source: Author, 2026.

Renewable energy is a crucial component in addressing the infrastructural limitations of remote tourism destinations, especially in areas where conventional electricity supply is unstable, expensive, or geographically difficult to extend. Off-grid solar power offers an alternative that can support basic tourism services, digital devices, communication facilities, lighting, and internet infrastructure without increasing dependence on fossil-fuel-based energy systems.

In rural and island contexts, renewable-based electrification has also been linked to poverty reduction, productive activities, and local economic opportunities when it is designed according to community needs and institutional capacity. For tourism destinations such as remote beaches, the integration of solar energy and digital connectivity is particularly relevant because it supports both environmental sustainability and operational continuity. Thus, renewable energy should be understood as a strategic foundation for green tourism infrastructure, not merely as a technical substitute for conventional electricity (Mainali et al., 2011; Blum et al., 2013; Wirawan et al., 2021; Islami et al., 2021).

Community empowerment is another important aspect because sustainable tourism development cannot rely only on the installation of technology. Digital infrastructure will produce limited impact if local residents do not have the capacity, confidence, and opportunity to use it for tourism promotion, service innovation, and community-based economic activities. Empowerment in rural tourism involves strengthening local agency, improving digital literacy, encouraging participation in decision-making, and enabling residents to become co-producers of tourism value rather than passive recipients of development programs. When communities are actively involved, digital transformation can support local storytelling, small business promotion, visitor communication, and the development of tourism services that reflect local identity. Therefore, the success of digital tourism intervention depends on the interaction between technology, community readiness, social trust, and participatory governance (Mendoza-Moheno et al., 2021; Alamineh et al., 2023; Huo et al., 2023; Lapuz, 2023).

Table 2. Integrated Dimensions of Green Digital Connectivity for Sustainable Rural Tourism Development

No.	Dimension	Focus	Relevance to Nanggelan Beach Tourism Development
1	Technological Inclusion	Provision of internet access through IoT-	Improves destination visibility, supports online promotion, and

No.	Dimension	Focus	Relevance to Nanggelan Beach Tourism Development
		based digital infrastructure	expands access to tourism information in a remote coastal area
2	Renewable Energy Sustainability	Use of off-grid solar power as an alternative energy source	Ensures operational continuity of digital infrastructure in an area with limited electricity access while supporting green tourism principles
3	Community Empowerment	Strengthening local digital literacy and participatory capacity	Encourages local residents to become active actors in tourism promotion, service innovation, and community-based economic development
4	Tourism Promotion	Utilization of digital platforms and social media	Expands public awareness of Nanggelan Beach and increases opportunities to attract visitors through digital visibility
5	Socio-Economic Opportunity	Integration of connectivity, tourism, and local participation	Creates potential income opportunities through improved tourism access, promotion, and service development

Source: Author, 2026.

This study responds to the above research gap by examining Nanggelan Beach in Jember, Indonesia, as a case of green digital connectivity in a remote coastal tourism destination. The article focuses on the implementation of an IoT-based off-grid solar internet system as a socio-technical intervention that connects technological inclusion, renewable energy sustainability, and community empowerment. The author's approach is to position digital infrastructure not merely as a technical facility, but as a development mechanism that can improve destination visibility, support community participation, and expand socio-economic opportunities in underserved rural tourism areas. By using a qualitative descriptive case study approach supported by observation, stakeholder interviews, and social media analysis, this research seeks to understand how digital connectivity influences tourism promotion and local community behavior in a real destination context (Zainal-Abidin et al., 2023; Parra-Sanchez & Viviescas-Jaimes, 2024; Sukma et al., 2025; Tricahyono et al., 2026).

The originality of this article lies in its attempt to integrate three fields that are commonly discussed separately: smart tourism, renewable energy infrastructure, and community-based rural tourism development. Through the case of Nanggelan Beach, this study argues that sustainable tourism transformation in remote coastal areas requires more than destination promotion or physical infrastructure improvement. It requires a green digital connectivity model that combines internet access, renewable energy, local capacity building, and participatory tourism practices. Accordingly, this article contributes to the broader discourse on sustainable rural tourism by

demonstrating how digital infrastructure powered by renewable energy can reduce infrastructural inequality, strengthen local empowerment, and support more inclusive tourism development in peripheral coastal destinations.

RESEARCH METHOD

This study employed a qualitative case study design to examine how digital connectivity through an IoT-based off-grid solar internet system contributes to rural tourism development and community empowerment at Nanggelan Beach, Jember. A descriptive-exploratory approach was used to understand the social, technological, and economic implications of implementing a solar-powered internet network in a remote coastal tourism area. This design enabled the phenomenon to be examined holistically within its real-life context (Yin, 2014). The study was conducted in Dusun Jawala, Nanggelan Beach, Jember Regency, East Java, involving key stakeholders such as local residents, tourism operators, visitors, community leaders, and project facilitators. Participants were selected purposively, with 35 individuals involved in the broader evaluation process, including 12 residents, two community leaders, and one project facilitator who participated in semi-structured interviews.

Data collection was carried out between May and August 2023 after the installation of the IoT-based solar internet system. The empirical data were obtained through semi-structured interviews, participant observation, evaluation forms, project documents, and social media content analysis. These methods were used to strengthen data triangulation and improve the validity of the findings (Creswell, 2018). Interviews explored participants' experiences with digital connectivity, tourism promotion, and perceived community benefits, while observations documented community responses during installation, training, and digital content creation activities. Social media analysis focused on Instagram activity from the official community tourism account, including posting frequency, follower growth, engagement patterns, and tourism-related content themes.

The collected data were analyzed using thematic content analysis through six stages: data familiarization, initial coding, theme identification, theme review, theme definition, and report writing (Braun & Clarke, 2006). The main themes included digital access and inclusion, tourism promotion outcomes, community empowerment, and sustainability implications. Ethical procedures were applied by informing participants about the research purpose, ensuring voluntary participation, obtaining informed consent, anonymizing responses, and protecting personal data. The research received ethical approval from the Institutional Review Board of Politeknik Negeri Jember and followed the principles of transparency, respect, and beneficence (BRIN, 2022).

RESULT AND DICUSSION

1. Technological Performance of the IoT-Based Solar Internet System

The first analytical dimension concerns the technological performance of the IoT-based off-grid solar internet system as the foundational infrastructure enabling digital transformation at Nanggelan Beach. The system was implemented between May and August 2023 through collaboration between local community members and students from Politeknik Negeri Jember as part of a rural digital empowerment initiative. Designed specifically for deployment in an infrastructure-constrained coastal environment, the

system consisted of a 400 Wp photovoltaic solar panel array, a 100 Ah deep-cycle battery storage unit, a charge regulation mechanism, a wireless router, a signal repeater, and IoT-enabled monitoring components used to supervise connectivity stability and energy availability.

This configuration addressed two major infrastructural limitations in the study area: weak telecommunications signals and the absence of a stable national electricity connection. Solar-generated energy was stored in the battery system and regulated to ensure uninterrupted operation of the networking equipment, while the router and repeater distributed internet access across an approximate 50-meter operational radius. The inclusion of IoT-based monitoring enabled basic supervision of energy performance and network functionality, allowing the system to remain operational under fluctuating environmental conditions typical of remote coastal settings. This aligns with broader discussions on IoT-enabled infrastructure, which emphasize the role of connected systems in improving operational efficiency, remote monitoring, and adaptive infrastructure management (Li et al., 2015).

Field observations indicated that the system maintained relatively stable performance throughout the implementation period, with an average nighttime battery reserve of approximately 70%, suggesting adequate energy retention for continuous operation. This finding demonstrates the technical feasibility of integrating renewable energy infrastructure into rural tourism support systems, particularly in geographically isolated destinations where conventional utility expansion remains economically impractical. Previous studies have similarly emphasized the viability of decentralized solar systems as sustainable infrastructure solutions for underserved rural regions (Palit & Chaurey, 2011; Moner-Girona et al., 2021).

Beyond connectivity provision, the system also contributed to broader environmental sustainability objectives. Compared with conventional fuel-powered generators, the solar-powered configuration eliminated recurring fuel costs, reduced operational noise, and minimized carbon-intensive energy dependence. This aligns with contemporary sustainable tourism principles, which increasingly emphasize environmentally responsible infrastructure development as part of destination competitiveness (World Tourism Organization, 2023). Thus, the technological intervention functioned not merely as an internet access solution, but as a green infrastructure model that combined digital inclusion with renewable energy resilience.

The findings also reinforce the relevance of smart tourism frameworks, which conceptualize technology as an enabler of adaptive destination management rather than merely a communication tool (Gretzel et al., 2015; Buhalis & Amaranggana, 2015). In the Nanggelan case, digital connectivity became possible not through conventional urban infrastructure, but through context-sensitive technological adaptation that responded directly to local environmental constraints. This finding also resonates with rural digital development literature, which argues that connectivity infrastructure constitutes a critical prerequisite for reducing structural inequalities between peripheral and urban regions (Salemink et al., 2017).

2. Digital Visibility and Tourism Promotion Outcomes

The second analytical dimension concerns how digital connectivity influenced destination visibility and tourism promotion. Prior to the installation of the solar-powered

internet system, Nanggelan Beach had minimal digital presence, with only limited tourism-related online references and almost no structured promotional activity managed by local residents. Tourism marketing relied primarily on informal word-of-mouth communication, which constrained the destination's ability to reach broader visitor markets.

Following the establishment of internet access and community digital literacy activities, a noticeable transformation in online visibility emerged. Social media observations conducted between May and August 2023 showed increased promotional activity through the community's official Instagram account, which reached approximately 833 followers during the observation period. Tourism-related posts featuring Nanggelan Beach increased substantially, accompanied by higher levels of visible engagement, including likes, comments, and content sharing. These findings suggest that digital accessibility played a direct role in expanding the destination's online exposure and promotional reach. Previous studies have similarly shown that digital communication platforms can significantly enhance destination visibility, visitor engagement, and tourism market reach, particularly for smaller or peripheral destinations (Munar & Jacobsen, 2014; Gretzel et al., 2015).

A particularly significant shift occurred in the role of local youth as active tourism content creators. Rather than relying on external tourism promoters, community members began producing and disseminating visual storytelling content showcasing the destination's coastal scenery, biodiversity, coral reef environment, and recreational experiences. This transformation reflects broader arguments in tourism communication literature, which emphasize the role of participatory digital storytelling in strengthening destination authenticity, trust, and emotional engagement among potential visitors (Munar & Jacobsen, 2014). Similar dynamics have been observed in Indonesian rural tourism contexts, where community-generated storytelling has been shown to strengthen cultural visibility and local resilience through digital platforms (Nanita, 2025).

The Nanggelan case demonstrates that digital connectivity can serve as more than a communication utility; it can function as an enabling platform for bottom-up destination branding. Similar findings have been observed in studies of rural tourism transformation, where community-generated narratives increasingly shape destination identity and visitor perceptions (Scheyvens, 1999; Salemink et al., 2017). In this context, digital storytelling also strengthened local ownership over how Nanggelan Beach was represented, reducing dependence on externally mediated tourism narratives.

These outcomes resonate with recent tourism studies suggesting that technological inclusion is a critical prerequisite for sustainable destination competitiveness, particularly in rural and peripheral tourism contexts (Buhalis & Amaranggana, 2015; Gretzel et al., 2015). While previous studies often focus on visitor-facing smart tourism applications, the present findings shift attention toward connectivity as an upstream enabling condition that empowers local communities to participate in tourism visibility creation.

3. Community Empowerment and Digital Capacity Building

Beyond technological performance, the implementation of the IoT-based solar internet system generated significant social impacts, particularly in strengthening community capacity and digital empowerment. A total of 25 local residents, primarily

youth and small-scale tourism entrepreneurs, participated in training activities focused on digital literacy, basic network maintenance, solar system troubleshooting, and tourism content creation. These activities transformed digital connectivity from a passive infrastructural provision into an active community resource, enabling local stakeholders to engage directly with tourism development processes.

Interview findings indicated that approximately 76% of participants reported increased confidence in interacting with tourists and promoting Nanggelan Beach through digital platforms. This suggests that connectivity alone is insufficient unless accompanied by human capacity-building interventions that enable communities to meaningfully utilize technological access. The findings align with Scheyvens' (1999) empowerment framework, which argues that tourism development becomes genuinely participatory when local communities gain control over knowledge, representation, and decision-making processes.

A particularly notable outcome was the emergence of collective local ownership over digital tourism promotion. Youth groups and local associations collaborated to form the Nanggelan Digital Team, an informal community initiative responsible for maintaining online promotional activities and supporting basic technical system management. This shift reflects a broader transformation from externally dependent tourism promotion toward locally driven digital stewardship.

The findings also resonate with contemporary discussions on digital inclusion in rural development, which emphasize that technological access should be understood not merely as connectivity provision, but as the expansion of social capabilities and participation opportunities (Salemink et al., 2017). In this context, digital literacy functioned as both a tourism development mechanism and a community empowerment strategy. By enabling local residents to create, manage, and disseminate tourism narratives independently, the intervention strengthened both individual agency and collective social capital.

From a community-based tourism perspective, this transformation is particularly significant. Previous scholarship has consistently emphasized that sustainable tourism requires local participation beyond symbolic consultation (Timothy, 1999). The Nanggelan case demonstrates that digital tools can enhance this participation by creating new avenues for self-representation, collaborative destination branding, and decentralized tourism governance. Thus, digital empowerment emerged as a critical mediating factor between technological infrastructure and sustainable tourism outcomes.

4. Socio-Economic Impacts on Rural Tourism Development

The fourth analytical dimension concerns the socio-economic implications of digital connectivity for rural tourism development. Stakeholder interviews consistently indicated that the improved online visibility of Nanggelan Beach contributed to perceived increases in weekend visitor activity following the implementation period. Although formal baseline tourism statistics were unavailable, multiple respondents, including local vendors and tourism operators reported noticeable increases in visitor inquiries, parking activity, and food sales, suggesting positive tourism-related economic spillover effects.

These findings should be interpreted cautiously, as visitor growth cannot be attributed exclusively to internet connectivity alone. Other contributing factors, including seasonal tourism patterns, informal word-of-mouth promotion, and concurrent community tourism initiatives, may also have influenced visitor dynamics. Nevertheless, the consistency of stakeholder perceptions suggests that digital visibility played a meaningful enabling role in enhancing destination awareness and tourism accessibility.

The intervention also contributed to economic diversification within the local tourism ecosystem. Small-scale vendors, food sellers, and tourism service providers reported greater opportunities to engage with visitors, while digital promotion created new entrepreneurial possibilities for community members involved in content production and destination marketing. These findings align with broader research suggesting that digital communication platforms can expand tourism market reach, improve destination discoverability, and strengthen local participation in tourism economies, particularly in previously underserved areas (Munar & Jacobsen, 2014; Salemink et al., 2017).

More broadly, the findings suggest that digital infrastructure can function as a catalyst for rural tourism transformation when embedded within community participation frameworks. Rather than simply improving internet access, the intervention created pathways for broader socio-economic inclusion by expanding access to information, communication, and tourism-related economic opportunities. This aligns with smart tourism perspectives that increasingly recognize connectivity infrastructure as an upstream enabling condition for destination competitiveness, particularly in peripheral and underserved regions (Gretzel et al., 2015). In Nanggelan, the socio-economic value of connectivity extended beyond technical convenience, becoming part of a broader process of rural tourism activation and community resilience-building.

5. Integrated Sustainability Implications and Conceptual Contribution

The findings of this study demonstrate that rural digital connectivity should not be understood solely as a technical infrastructure intervention, but as a multidimensional enabler of sustainable tourism transformation. The Nanggelan Beach case reveals how technological access, renewable energy integration, and community participation can converge to create broader developmental outcomes that extend beyond connectivity provision alone. Rather than functioning merely as a communication utility, the IoT-based solar internet system became an enabling platform for digital inclusion, participatory destination promotion, local skill development, and emerging socio-economic opportunities.

From a smart tourism perspective, the study supports the argument that destination intelligence does not depend exclusively on advanced urban technologies, but can also emerge through context-sensitive technological adaptation in resource-constrained environments (Buhalis & Amaranggana, 2015; Gretzel et al., 2015; Xiang et al., 2015). Unlike mainstream smart tourism models that often emphasize sophisticated visitor-facing digital applications, the present case highlights connectivity itself as a foundational prerequisite for tourism participation and destination visibility in rural settings. This distinction is particularly relevant for developing-country contexts, where infrastructural inequalities continue to shape tourism competitiveness.

The findings also extend community-based tourism scholarship by demonstrating that digital empowerment can strengthen local agency and self-representation. Consistent with Scheyvens (1999), meaningful tourism participation requires more than community inclusion in planning processes; it requires access to tools, knowledge, and communication channels that allow communities to actively shape tourism narratives and opportunities. In Nanggelan, digital literacy training and locally managed promotional activities transformed community members from passive tourism beneficiaries into active co-creators of destination identity.

Equally significant is the study's contribution to sustainable energy discourse within tourism development. While renewable energy is frequently discussed in relation to operational sustainability, this study demonstrates that off-grid solar systems can simultaneously support digital infrastructure, tourism promotion, and social inclusion in remote destinations. This integrated socio-technical perspective expands conventional discussions of rural electrification by positioning renewable energy as a catalyst for tourism transformation rather than solely an energy access solution.

Taken together, these dimensions are synthesized in Figure 1, which presents an integrated conceptual model of green digital connectivity for sustainable rural tourism development.

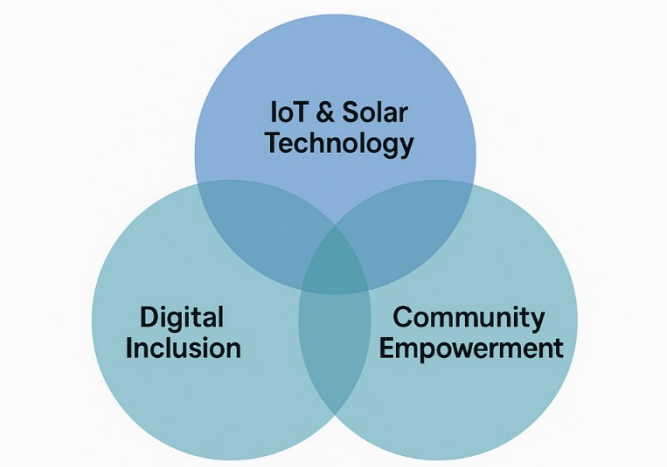

Figure 1. Integrated Framework of IoT Connectivity, Community Empowerment, and Sustainable Rural Tourism Development
Source: Author's conceptual synthesis

As illustrated in Figure 1, the conceptual framework positions IoT-based solar connectivity as the enabling technological foundation that supports four interconnected sustainability dimensions: technological resilience, digital destination visibility, community empowerment, and socio-economic tourism development. These interactions collectively contribute to broader sustainable development objectives, including affordable clean energy, inclusive economic growth, and resilient community-based tourism systems. The framework therefore offers a transferable conceptual contribution for understanding how green digital transformation may support tourism development in other underserved rural destinations facing similar infrastructural constraints.

More broadly, the study suggests that sustainable rural tourism competitiveness should be reconceptualized not merely through physical destination infrastructure, but through integrated socio-technical systems that strengthen local capacity, environmental responsibility, and digital inclusion. This contribution is particularly relevant in the context of post-pandemic tourism recovery and growing policy interest in equitable digital transformation for regional development.

CONCLUSION

This study demonstrates that digital connectivity, when integrated with renewable energy infrastructure and community participation, can function as a transformative enabler of sustainable rural tourism development. Through the case of Nanggelan Beach, the findings show that the implementation of an IoT-based off-grid solar internet system improved digital accessibility, strengthened destination visibility, enhanced local digital capacity, and contributed to emerging socio-economic opportunities within a remote coastal tourism context. Rather than serving merely as a technical infrastructure intervention, digital connectivity operated as a socio-technical catalyst that enabled local communities to actively participate in tourism promotion, destination management, and broader processes of rural transformation.

The study contributes theoretically to the growing intersection of smart tourism, sustainable rural development, and community-based tourism by demonstrating that digital inclusion should be understood as a foundational condition for tourism competitiveness in infrastructure-constrained destinations. Unlike previous studies that often examine smart tourism technologies, renewable energy systems, or community participation in isolation, this research offers an integrated empirical perspective showing how green digital infrastructure can simultaneously support technological resilience, social empowerment, and tourism development. Practically, the findings suggest that relatively small-scale, community-oriented investments in renewable digital infrastructure can provide meaningful developmental benefits for underserved rural destinations.

Several limitations should be acknowledged. As a single-site qualitative case study, the findings reflect context-specific dynamics and do not permit broad generalization. The study also relied primarily on stakeholder perceptions and short-term observational evidence, without baseline quantitative tourism data to establish direct causal attribution between internet connectivity and visitor growth. Future research should therefore adopt longitudinal and comparative approaches, incorporating mixed-method designs to evaluate long-term economic, environmental, and tourism impacts across diverse rural destinations.

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