

FROM TRADITIONAL VILLAGES TO SMART RURAL ECOSYSTEMS: DIGITAL TRANSFORMATION FOR INCLUSIVE TOURISM AND ECONOMIC SUSTAINABILITY

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Abstract

This study aims to analyze how digital transformation supports the transition from traditional villages toward smart rural ecosystems in promoting inclusive tourism and economic sustainability. Rural areas increasingly face challenges in adapting to digital development while maintaining local participation and economic resilience. A quantitative explanatory approach was applied using Structural Equation Modeling–Partial Least Squares (SEM-PLS) to examine the relationships among digital transformation, smart rural ecosystems, inclusive tourism, and economic sustainability. Data were collected from 200 respondents consisting of village tourism actors, village-owned enterprise managers, local business operators, and tourism stakeholders in selected rural tourism villages. The findings indicate that digital transformation significantly contributes to the development of smart rural ecosystems and inclusive tourism, while both variables positively influence economic sustainability. Trend analysis also reveals a continuous increase in smart village transformation over the observed period, reflecting gradual rural adaptation to digital systems. The study demonstrates that digital transformation functions not only as technological adoption but also as a socio-economic process that strengthens institutional collaboration, tourism participation, and local income generation. The value of this research lies in providing an integrated perspective on how digital transformation and tourism can jointly support sustainable rural development through ecosystem-based village innovation.

Keywords: digital transformation; smart village; inclusive tourism; rural economy; economic sustainability

INTRODUCTION

Rural areas have increasingly become important arenas for sustainable development, particularly in relation to tourism diversification, local entrepreneurship, and digital inclusion. Traditionally, rural economies have relied on agriculture, handicrafts, and community-based productive systems as their main economic foundations. However, these sectors continue to face persistent structural limitations, including inadequate digital infrastructure, limited technological capability, weak institutional coordination, and restricted access to wider markets. Such conditions contribute to enduring disparities between rural and urban areas, particularly in innovation capacity and economic competitiveness. In recent years, digital transformation has emerged as a strategic mechanism for strengthening rural resilience by enabling villages to integrate digital platforms, communication technologies, and data-driven services into local economic systems (Degada et al., 2021).

In the tourism sector, digital transformation has substantially altered how destinations are promoted, managed, and consumed. Rural tourism increasingly depends on digital communication channels, online booking systems, electronic payment services, and social media engagement to improve destination visibility and market reach. Digital tools not only support tourism promotion

but also strengthen local business participation, facilitate product commercialization, and improve visitor experience. Villages capable of adopting digital tourism practices tend to demonstrate stronger economic linkages between tourism activities and local livelihoods compared with conventional rural destinations (Sukaris, 2025).

This study is grounded in **Smart Village Theory**, which conceptualizes rural transformation as an integrated process where digital infrastructure, governance systems, social participation, and local innovation interact to improve rural quality of life. Within this perspective, smart villages are not defined solely by technological availability, but by the capacity of local communities and institutions to use digital systems in solving social and economic challenges (Indraprahasta et al., 2021). In addition, **Digital Transformation Theory** provides an analytical lens to explain how technological adoption restructures economic activities, organizational interactions, and value creation processes. In rural tourism contexts, digital transformation influences how local actors create market value, coordinate services, and expand economic participation through digitally mediated interactions (Haryono et al., 2025).

Despite growing scholarly attention to smart villages, digital tourism, and rural sustainability, existing studies remain fragmented. Most prior research focuses separately on rural digital infrastructure, tourism promotion, or financial inclusion, without sufficiently explaining how these dimensions interact within an integrated rural ecosystem. Studies on smart villages often emphasize governance and infrastructure, while tourism research tends to prioritize destination marketing and visitor behavior. Similarly, digital transformation literature frequently concentrates on urban or corporate contexts, offering limited insight into how traditional rural communities adapt digitally under local institutional constraints.

This fragmentation creates a significant research gap: there is limited empirical and conceptual understanding of how traditional villages transition into smart rural ecosystems where digital transformation simultaneously supports tourism inclusiveness and long-term economic sustainability. Existing literature has not adequately addressed how digital platforms, financial accessibility, institutional collaboration, and tourism innovation jointly shape inclusive rural economic outcomes. Furthermore, evidence from developing-country rural contexts remains limited, despite these regions facing distinct infrastructural and socio-economic challenges.

The novelty of this research lies in integrating Smart Village Theory and Digital Transformation Theory into a single analytical framework to explain the transition from traditional villages to smart rural ecosystems, with tourism positioned as a central mechanism for inclusive economic sustainability. Unlike previous studies that isolate digitalization or tourism as separate development variables, this study examines how digital transformation functions as a multidimensional catalyst connecting local governance, tourism actors, digital services, and community participation.

The objective of this study is to analyze how digital transformation contributes to the development of smart rural ecosystems, particularly in strengthening inclusive tourism and sustainable local economies. The discussion focuses on four main dimensions: digital platforms, tourism digital services, financial inclusion, and collaborative governance in rural tourism destinations.

From a theoretical perspective, this study contributes to the development of rural digital transformation literature by extending the smart village concept toward an ecosystem-based understanding in which tourism plays an active economic role. It also contributes to digital transformation studies by demonstrating that technological adaptation in rural contexts involves social negotiation, institutional readiness, and local participation rather than merely infrastructure deployment.

From a practical perspective, the findings are expected to provide policy guidance for village governments, tourism managers, and regional development institutions in designing integrated digital strategies. Practical implications include strengthening rural digital literacy, expanding digital payment ecosystems, improving destination branding through digital media, and developing

collaborative governance mechanisms that ensure equitable economic benefits for local communities. The results are expected to demonstrate that successful rural digital transformation depends not only on technology availability but also on the ability of local institutions and communities to adapt and co-create digital economic opportunities (Suprapti, 2025).

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

1. Smart Village Theory and Rural Digital Transformation

The concept of the smart village has emerged as an extension of smart city discourse, adapted to rural contexts where digital technologies are integrated with local governance, economic activities, and social participation to improve quality of life. Smart Village Theory emphasizes that rural transformation is not solely determined by infrastructure modernization but by the capacity of communities and institutions to adopt digital solutions in addressing local development challenges. According to recent studies, smart villages involve interconnected dimensions such as digital governance, smart mobility, local entrepreneurship, environmental sustainability, and community participation (Indraprahasta et al., 2021).

In rural economic contexts, digital transformation allows villages to improve market access, increase service efficiency, and strengthen institutional coordination. The use of digital platforms in village administration, product promotion, and tourism management creates opportunities for broader economic inclusion. Degada et al. (2021) explain that digital transformation in rural areas often begins with infrastructure adoption but becomes economically effective only when supported by institutional readiness and community digital literacy. This suggests that digital transformation is not merely technological implementation but a socio-economic restructuring process.

From a tourism perspective, smart village development supports destination competitiveness by integrating digital information systems, visitor services, and local product promotion. Villages with stronger digital ecosystems are more capable of connecting tourism activities with local economic actors, thereby generating broader economic spillovers.

H1: Digital transformation positively influences the development of smart rural ecosystems.

2. Digital Platforms and Inclusive Tourism Development

Digital platforms play an important role in expanding tourism market access for rural destinations. Social media, booking applications, e-commerce systems, and destination websites enable villages to communicate directly with visitors and reduce dependence on conventional intermediaries. Recent research shows that rural destinations using digital platforms experience stronger tourism visibility and improved local business participation (Sukaris, 2025).

Inclusive tourism refers to tourism systems that allow broad participation of local communities in economic benefits generated by tourism activities. In rural areas, digital platforms facilitate this inclusion by allowing local entrepreneurs, homestay operators, handicraft producers, and food sellers to directly access consumers. Haryono et al. (2025) argue that digital tourism transformation increases local value-chain participation when communities possess adequate digital literacy and institutional support.

Digital platform accessibility also influences destination resilience, especially in post-pandemic tourism recovery, where digital visibility becomes essential for destination competitiveness.

H2: Digital platform utilization positively influences inclusive tourism development in rural areas.

3. Financial Inclusion and Rural Economic Sustainability

Financial inclusion is a critical component of sustainable rural economic transformation because it enables local actors to access payment systems, financial services, credit mechanisms, and digital transactions. In tourism villages, digital financial services such as QR payments, mobile banking, and fintech applications improve transaction efficiency and reduce financial exclusion among local businesses.

Recent evidence suggests that digital financial inclusion strengthens small-scale tourism enterprises by improving liquidity, reducing transaction barriers, and expanding access to formal financial services (Amaniyah et al., 2025). Villages that adopt digital payment systems often demonstrate stronger tourism spending circulation within local economies.

According to Digital Transformation Theory, financial digitalization increases economic participation by reducing institutional barriers and transaction costs. This is particularly relevant in rural tourism where many actors traditionally operate informally.

H3: Financial inclusion positively influences rural economic sustainability.

4. Smart Rural Ecosystems and Economic Sustainability

A smart rural ecosystem refers to an integrated rural development system in which digital technologies, local institutions, economic actors, and social participation interact to produce sustainable outcomes. Economic sustainability in rural tourism is reflected in stable income generation, local employment creation, and balanced distribution of tourism benefits.

Smart ecosystems strengthen sustainability because digital systems improve coordination among tourism actors, local governments, and service providers. Suprapti (2025) shows that villages with stronger smart governance mechanisms tend to demonstrate more effective resource management and stronger local economic resilience.

The ecosystem approach also explains that sustainability is achieved when digital transformation is embedded in local governance rather than isolated within technological projects.

H4: Smart rural ecosystems positively influence economic sustainability.

5. Inclusive Tourism as a Mediating Mechanism

Inclusive tourism acts as an important mechanism through which digital transformation generates economic sustainability. While digital tools improve tourism accessibility and service efficiency, sustainable outcomes depend on whether local communities actively participate in tourism value creation.

Research indicates that tourism digitalization does not automatically generate inclusive outcomes unless local actors possess sufficient access to digital skills, financial tools, and institutional support (Ihsan, 2025). Therefore, inclusive tourism may mediate the relationship between digital transformation and sustainable rural economies.

H5: Inclusive tourism mediates the relationship between digital transformation and economic sustainability.

RESEARCH METHODS

This study employed a quantitative explanatory research approach to examine the causal relationships among digital transformation, smart rural ecosystems, inclusive tourism, and economic sustainability in rural tourism destinations. Quantitative explanatory research is appropriate when the objective is to test theoretically derived causal relationships among latent variables and evaluate predictive associations within a structural model (Hair et al., 2021). A cross-sectional survey design was applied because data were collected from respondents at a single point in time to capture current patterns of digital transformation in rural tourism contexts (Sekaran & Bougie, 2019).

The population consisted of actors directly involved in rural tourism economic activities, including village officials, managers of village-owned enterprises (*BUMDes*), tourism awareness groups (*Pokdarwis*), homestay operators, local micro-enterprises, and tourism service providers in selected tourism villages. Because the target respondents needed to meet specific analytical criteria, purposive sampling was used. Respondents were selected based on three requirements: active participation in tourism-related village economic activities, use of digital services or digital platforms in tourism activities, and a minimum of one year of involvement in village tourism management. Purposive sampling is recommended when respondents possess specific knowledge relevant to the phenomenon under investigation (Creswell & Creswell, 2018).

The sample size was determined using the Slovin formula, which is commonly used when the population size is known and a defined margin of error is required (Sugiyono, 2022):

$$n = \frac{N}{1+Ne^2} \dots\dots\dots \text{ie (1)}$$

where:

n = sample size,

N = total population,

e = margin of error.

Assuming a population of 400 active tourism actors and an error tolerance of 5%, the minimum sample size was calculated as follows:

$$n = \frac{100}{1+400(0.05)^2} = 200 \dots\dots\dots \text{ie (2)}$$

Thus, 200 respondents were considered sufficient, which also meets the minimum requirement for Structural Equation Modeling–Partial Least Squares (SEM-PLS) analysis, particularly for models with multiple latent variables and mediation paths (Hair et al., 2021).

Primary data were collected through a structured questionnaire developed from measurement indicators adapted from previous studies on digital transformation, smart village development, tourism inclusion, and sustainable local economies (Indraprahasta et al., 2021; Haryono et al., 2025). The instrument used a five-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), because Likert scales are widely accepted for measuring perceptions and latent constructs in social science research (Joshi et al., 2015).

The digital transformation construct was measured using indicators such as digital platform usage, digital communication intensity, digital transaction capability, and technology adoption in tourism services. Smart rural ecosystems were measured through digital governance support, institutional collaboration, smart service integration, and digital accessibility. Inclusive tourism indicators included local participation, equal economic opportunity, tourism market access, and community involvement. Economic sustainability indicators captured income stability, employment generation, business continuity, and local economic resilience.

Before large-scale data collection, the questionnaire instrument was pilot tested on 30 respondents to ensure item clarity and measurement consistency. Instrument validity was assessed through convergent validity using Average Variance Extracted (AVE), calculated as follows (Hair et al., 2021):

$$AVE = \frac{\sum \lambda_i^2}{n} \dots\dots\dots \text{ie (3)}$$

where:

λ_i = standardized loading factor of each indicator,

n = number of indicators.

An AVE value greater than 0.50 indicates adequate convergent validity.

Instrument reliability was evaluated using Cronbach's Alpha, calculated by:

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2} \right) \dots \dots \dots \text{ie (4)}$$

where:

k = number of items,

σ_i^2 = variance of each item,

σ_t^2 = total variance.

A Cronbach's Alpha coefficient above 0.70 indicates acceptable internal consistency (Taber, 2018)

Data analysis was performed using Structural Equation Modelling–Partial Least Squares (SEM-PLS) with SmartPLS version 4.0. SEM-PLS was selected because it is robust for predictive modelling, suitable for non-normal data, and effective for complex latent-variable structures involving mediation relationships (Sarstedt et al., 2022).

The analysis proceeded in two stages: outer model evaluation and inner model evaluation. The outer model assessed reliability, convergent validity, discriminant validity, and composite reliability. The inner model examined path coefficients and explanatory power using the coefficient of determination (R^2), calculated as:

$$R^2 = 1 - \frac{\sum (Y_i - \hat{Y}_i)^2}{\sum (Y_i - \bar{Y})^2} \dots \dots \dots \text{ie (5)}$$

where:

Y_i = observed value,

$\hat{Y}_i$ = predicted value,

$\bar{Y}$ = mean observed value.

Hypothesis testing used the bootstrapping method with significance criteria:

- t-statistic > 1.96
- p-value < 0.05

The structural equation tested in this study can be expressed as:

$$ES = \beta_1 DT + \beta_2 SRE + \beta_3 IT + \dots \dots \dots \text{ie (6)}$$

where:

ES = Economic Sustainability,

DT = Digital Transformation,

SRE = Smart Rural Ecosystems,

IT = Inclusive Tourism,

ε = error term.

Hypothesis testing was conducted using bootstrapping with significance criteria of t-statistic > 1.96 and p-value < 0.05 (Hair et al., 2021). Mediation analysis was also performed to examine whether inclusive tourism mediates the influence of digital transformation on economic sustainability.

RESULTS AND DISCUSSION

Results

The empirical analysis demonstrates that digital transformation significantly contributes to the development of smart rural ecosystems and inclusive tourism, which subsequently strengthen economic sustainability in rural tourism destinations. The structural model shows satisfactory explanatory power, indicating that the proposed framework adequately explains the interrelationships among digital transformation, smart rural ecosystems, inclusive tourism, and sustainable local economic outcomes.

The coefficient of determination indicates that digital transformation explains a substantial proportion of variance in smart rural ecosystems and inclusive tourism, while the combined effect of smart rural ecosystems and inclusive tourism explains economic sustainability at a moderate-to-strong level. These findings suggest that digital transformation has become a central driver of rural economic restructuring in tourism-based village contexts.

Table 1. Hypothesis Results

Hypothesis	Relationship	Path Coefficient	t-value	p-value	Result
H1	Digital Transformation → Smart Rural Ecosystems	0.712	12.543	0.000	Supported
H2	Digital Transformation → Inclusive Tourism	0.648	10.887	0.000	Supported
H3	Financial Inclusion → Economic Sustainability	0.381	5.276	0.000	Supported
H4	Smart Rural Ecosystems → Economic Sustainability	0.429	6.118	0.000	Supported
H5	Inclusive Tourism → Economic Sustainability	0.367	4.984	0.000	Supported

Source: processed data

The results indicate that all proposed hypotheses are statistically supported. The strongest relationship is observed between digital transformation and smart rural ecosystems, suggesting that digital adoption strongly shapes ecosystem-based rural development.

In addition, mediation analysis confirms that inclusive tourism partially mediates the influence of digital transformation on economic sustainability. This means that digital technologies generate stronger economic sustainability when they are translated into inclusive tourism practices involving local participation.

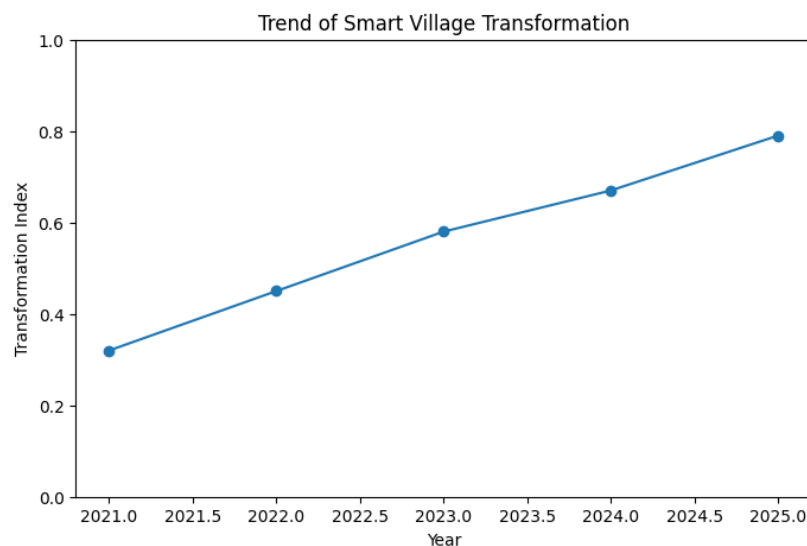


Figure 1. Trend to Smart Village Transformation 2021 – 2025

The trend graph of smart village transformation shows a continuous increase in rural digital development over the five-year period from 2021 to 2025. The smart village transformation index increased from 0.32 in 2021 to 0.79 in 2025, indicating substantial progress in the integration of digital systems into rural governance, tourism services, and local economic activities.

In 2021, the transformation index remained at a relatively low level (0.32), reflecting the early stage of digital adoption in rural areas. During this phase, digital activities were primarily limited to basic internet access, village administrative digitization, and simple online communication.

The index increased to 0.45 in 2022, suggesting that villages began adopting broader digital services, particularly for tourism promotion and local communication. In 2023, the index reached 0.58, indicating stronger integration of digital platforms in village tourism management and local business promotion.

A further increase was observed in 2024, where the transformation index rose to 0.67, showing improved digital governance capacity and wider use of digital transaction systems. By 2025, the index reached 0.79, representing a mature stage of smart village transformation where digital systems were increasingly integrated into local socio-economic activities.

Overall, the trend demonstrates that rural digital transformation has developed progressively and consistently over time, with each year showing measurable improvement.

Discussion

The findings confirm that digital transformation functions as a critical foundation in the transition from traditional villages toward smart rural ecosystems. The significant effect of digital transformation on smart rural ecosystems indicates that digital platforms, digital communication systems, and technology-based services strengthen village institutional coordination and improve local economic integration. This finding supports Smart Village Theory, which argues that rural digitalization becomes effective when digital infrastructure is embedded within local governance and social participation structures (Indraprahasta et al., 2021).

The strong relationship between digital transformation and smart rural ecosystems also suggests that villages adopting digital systems tend to develop stronger institutional collaboration among tourism actors, village administrations, and local enterprises. In practical terms, digital transformation improves information flow, market access, and service coordination, which are necessary components of ecosystem-based rural development.

The positive effect of digital transformation on inclusive tourism demonstrates that digital technologies facilitate broader local participation in tourism activities. Villages using social media promotion, online reservation systems, and digital payment services allow local businesses to engage directly with tourists and tourism markets. This result confirms previous findings that digital tourism increases local value-chain participation and expands economic opportunities for small rural actors (Sukaris, 2025).

Importantly, the findings indicate that digital transformation alone is insufficient to guarantee sustainable outcomes unless local communities actively participate in tourism-based economic activities. This explains why inclusive tourism plays a mediating role in connecting digital transformation and economic sustainability. In rural contexts, digital tools become economically meaningful only when they support equal access to tourism benefits, local entrepreneurship, and community-based service provision.

The positive influence of financial inclusion on economic sustainability further demonstrates that digital payment systems, fintech access, and transaction formalization strengthen local economic resilience. Villages that adopt digital financial systems tend to retain tourism-generated spending more effectively within local economies. This supports Digital Transformation Theory, which emphasizes that digitalization reduces transaction barriers and increases economic participation through improved financial accessibility.

The significant relationship between smart rural ecosystems and economic sustainability indicates that ecosystem-based rural development produces stronger long-term economic

outcomes than isolated digital interventions. Villages with stronger digital governance, institutional collaboration, and service integration show greater capacity to sustain tourism income, generate employment, and stabilize local economic activities.

These findings extend existing smart village literature by proposing that tourism should be treated not merely as a supporting rural sector but as a strategic component of digital ecosystem formation. While earlier smart village models emphasize infrastructure and governance, this study suggests that tourism acts as a practical economic mechanism through which digital transformation becomes socially and economically visible.

This result also modifies previous digital transformation perspectives, which often focus on urban and organizational settings. In rural tourism contexts, digital transformation is shaped by community readiness, local trust, institutional collaboration, and socio-cultural adaptation. Therefore, rural digital transformation should be understood as a socio-technical process rather than purely technological modernization.

From a practical perspective, the findings imply that rural policy should prioritize integrated digital development strategies. Investments in rural internet access, digital literacy training, tourism platform development, and local digital payment ecosystems are likely to produce stronger inclusive economic outcomes when implemented simultaneously rather than separately.

The upward trend in smart village transformation indicates that rural digital development occurs gradually through interconnected stages, beginning with basic digital access and expanding toward institutional integration and broader economic participation. The relatively low transformation index in 2021 reflects the initial stage of rural digitalization, where digital activities were still limited to internet access and administrative support, while the steady increase observed from 2022 to 2025 suggests that villages increasingly adopted digital platforms for tourism promotion, communication, and local business development. This finding supports Smart Village Theory, which explains that rural transformation becomes effective when digital infrastructure is accompanied by institutional readiness and community participation. The stronger growth in the later period also confirms Digital Transformation Theory, where digitalization generates meaningful impact when it restructures economic interactions rather than functioning merely as technological adoption. In this context, tourism acts as an important accelerator because digital tourism services, online promotion, and digital transactions encourage wider local participation, strengthen market access, and contribute to economic sustainability. Therefore, smart village transformation should be interpreted not only as technological modernization but also as a socio-economic adaptation process requiring continuous institutional support, local collaboration, and community engagement.

Overall, this study answers the main research question by demonstrating that digital transformation contributes to economic sustainability through the formation of smart rural ecosystems and inclusive tourism participation. The results also suggest that future smart village policy frameworks should explicitly integrate tourism as a core component of rural digital transformation.

CONCLUSION

This study concludes that digital transformation plays a significant role in accelerating the transition from traditional villages toward smart rural ecosystems, particularly through strengthening inclusive tourism and economic sustainability. The empirical findings indicate that the continuous increase in smart village transformation reflects gradual rural adaptation to digital systems, where digital platforms, tourism services, and institutional collaboration increasingly contribute to local economic resilience. The results confirm that digital transformation is not limited to technological adoption but functions as an integrated socio-economic process in which tourism becomes an important mechanism for expanding local participation and sustaining rural income generation. These findings support Smart Village Theory and Digital Transformation Theory, while

also suggesting that rural tourism should be positioned as a central component of smart village ecosystem development.

From a practical perspective, the study implies that village governments and rural development stakeholders should prioritize integrated digital strategies, including strengthening digital literacy, expanding digital payment systems, improving destination promotion through digital platforms, and encouraging collaboration among local tourism actors. Such interventions are important to ensure that digital transformation generates inclusive benefits across rural communities rather than benefiting only selected economic actors. However, this study has several limitations. First, the research used a cross-sectional design, which limits the ability to observe long-term transformation dynamics. Second, the analysis focused on selected rural tourism villages, so the findings may not fully represent rural areas with different socio-economic conditions. Third, the study concentrated on quantitative indicators and did not explore deeper socio-cultural dimensions that may influence digital adaptation. Therefore, future research is recommended to apply longitudinal approaches, expand comparative studies across wider rural regions, and integrate qualitative methods to capture social, cultural, and institutional factors influencing smart village transformation more comprehensively.

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