

Reimagining Rural Spaces: A Narrative Literature Review on the Role of Augmented Reality in Sustainable Rural Spatial Transformation

Ika Devi Perwitasari, Jodi Hendrawan, Dwi Wiryani

Abstract

This research aims to examine and synthesize various scientific literature discussing the role of Augmented Reality (AR) technology in transforming village space and supporting sustainable development in rural areas. Using a Narrative Literature Review (NLR) approach to seventeen international academic sources (2020–2025), this research explores the relationship between spatial transformation, digital empowerment, and spatial justice in the context of rural digitalization. The results of the synthesis indicate that the integration of AR in rural contexts results in a new form of collaborative and participatory digital space production, where communities are actively involved in the design, planning, and management of immersive technology-based spaces. AR has been shown to strengthen social, economic, and ecological connectivity in villages by increasing digital literacy, citizen participation, and increasing the efficiency of spatial data-driven development. Furthermore, digitalization oriented toward spatial justice also expands residents' access to information, resources, and local economic opportunities. This study proposes a new conceptual model, the AR-Driven Rural Spatial Transformation Model, which integrates three main components: (1) digital spatial transformation, (2) community technological empowerment, and (3) sustainable spatial justice. This model provides a theoretical contribution to the development of digital village development studies and offers policy directions that emphasize inclusivity, collaboration, and sustainability. Overall, the results of this study confirm that AR is not only a technological innovation but also a new social and spatial medium that reconstructs the relationship between people, space, and sustainable development in rural areas.

Keywords: Augmented Reality; Village Space Transformation; Digital Innovation; Sustainable Development; Smart Countryside; Spatial Justice; Digital Empowerment; Rural Modernization.

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Introduction

The development of digital technology has revolutionized the way people understand and manage space, particularly in rural areas [1], [2]. Innovations such as Augmented Reality (AR) introduce new forms of spatial experience that combine physical and virtual space, creating a hybrid reality that challenges traditional boundaries between rural and urban areas. In this context, theories of spatial transformation and rural modernization are crucial for understanding how digital innovation contributes to social, economic, and ecological restructuring in rural areas. Lefebvre views space as a dynamic social construction and always in the process of production [3]. Similarly, Liu emphasize that modern rural development can no longer be separated from urban development; the two are interdependent and reflect a reciprocal process of revitalization [3]. This concept demonstrates that digital technologies such as AR are not merely technical tools but also agents of social transformation that reconstruct the meaning, function, and equity of rural space.

Understanding spatial transformation in the rural context cannot be separated from the dimensions of spatial justice and rural modernization. Tu and Long explain that rural restructuring encompasses changes in the social, economic, and morphological aspects of settlements [4], which aligns with Lefebvre's notion of space as a constantly changing social entity. In this process, spatial justice serves as a crucial moral and policy framework to ensure that rural modernization does not deepen inequality but instead expands access to the benefits of development. Tang and Chen demonstrate that the development of digital infrastructure in rural areas plays a crucial role in bridging the urban-rural gap through increased land use efficiency and green transformation [5]. Thus, digitalization serves as an instrument of spatial justice, enabling equitable access to resources, information, and economic opportunities for rural communities.

A series of recent studies confirms that changes in rural structures occur through the interaction between digital innovation, public policy, and local social structures. Zhang and Zhang identified that the driving forces of rural transformation in China stem from internal mechanisms, external support, and policy interventions [6]. This aligns with Ge and Yu-qi's view that social space is always produced through integrated power relations and development policies [7]. More broadly, Wang demonstrate that rural tourism has great potential as a catalyst for ecologically based modernization [8], not only driving the rural economy but also strengthening the community's socio-cultural identity. Therefore, rural transformation in the digital era must be viewed as a multidimensional process encompassing the interaction between technology, society, and policy in creating equitable and sustainable spaces.

In the context of immersive technology [9], Augmented Reality plays a strategic role as a bridge between physical and digital spaces. Rauschnabel demonstrates that the use of AR devices, such as smart glasses, can enhance users perception and engagement with their environment through interactive experiences [10]. Research by Rauschnabel and Ro confirms that user motivation and technology acceptance are key factors in the successful integration of AR in communities, including community-based projects [11]. AR applications in education also show great potential. Lorusso found that AR can improve children's social and problem-solving skills [12], while Flores-Castañeda emphasized AR's role in enriching interactive learning environments [13]. This demonstrates that digital spatial experiences through AR are not merely visual but also have social, cognitive, and cultural implications in constructing participatory community spaces.

The integration of AR in the context of sustainable rural development reflects a technological dimension that goes beyond mere entertainment or education. Zambon highlight that the application of technology in rural development must consider social and ecological functions to support sustainability and local identity[14]. Effendi add that technology-based collaboration, including the use of AR, can strengthen village economic resilience and enhance

community entrepreneurial capacity [15]. Tian emphasize that the rural digital economy is a catalyst for revitalization that can optimize local resources through digital innovation [16]. In this context, AR has the potential to support the creative economy and ecotourism, expand residents' access to knowledge, and strengthen community-based economic structures in line with the SDGs (Goals 9 and 11).

The literature on community empowerment demonstrates that digital technology plays a role in strengthening the social and economic capacity of rural communities [17]. Fahmi and Arifianto explain that digitalization triggers social innovation that improves communication and local resource management [18]. Meanwhile, Zerrer and Sept highlight the concept of smart villages as a form of technology-based social innovation that enhances local resilience and citizen participation [19]. Zhang assert that the digital economy can accelerate the regeneration of the rural industrial sector [20], while Stojanova show that digital innovation hubs play a crucial role in improving digital literacy and social collaboration [21]. These studies emphasize that digital empowerment is not simply about access to technology, but also a socio-technical process that strengthens community independence in the face of structural changes in rural areas.

The integration of theories of social shaping of technology and spatial planning provides a conceptual basis for understanding the relationship between AR and village spatial transformation. Akbar propose an AR-based participatory model that incorporates community spatial knowledge into the village development planning process, strengthening citizen involvement in achieving the SDGs [22]. Wismantoro demonstrated that immersive technology can enrich nature-based tourism experiences and strengthen the ecological awareness of local communities [23]. Bravo added that AR can spark local innovation and create new economic opportunities oriented toward sustainability [24]. Septiyarini expanded this perspective by asserting that AR technology can strengthen relationships between communities and village governance [25], strengthening participatory democracy in spatial planning and public policy.

From the literature review, it can be concluded that there is still a research gap regarding the integration of spatial transformation theory, digital empowerment, and the application of AR in the context of sustainable rural development. Most previous research has focused on technological or economic aspects, while the spatial, social, and justice dimensions of space have not been widely explored in an integrative manner. The novelty of this research lies in its attempt to synthesize spatial transformation theory with AR-based digital innovation within the framework of spatial justice and sustainable rural development. This research also contributes theoretically by proposing a conceptual model for AR integration in a rural socio-spatial context that emphasizes citizen participation and socio-ecological sustainability.

The main research problem formulation of this research is: How does the scientific literature describe the role of Augmented Reality (AR) technology in transforming village spaces and promoting sustainable development in rural areas?

Literature Review

2.1 Theory of Spatial Transformation and the Production of Space in the Digital Era

The concepts of spatial transformation and the production of space serve as the main foundation for understanding how rural space is formed, interpreted, and transformed through digital technology. According to Lefebvre, space is not a passive entity, but rather a social construct that is constantly reproduced through social and economic interactions [3]. In the rural context, this theory is expanded by Tu and Long, who explain that rural restructuring encompasses multidimensional changes—from land use and economic activities to socio-cultural structures [4].

Liu emphasize that in modern rural revitalization, urban-rural relations are becoming increasingly interdependent [3], and digital technology is a key link between the two [26]. The

findings of Zhang and Zhang support this by demonstrating that the driving factors of rural transformation stem from a combination of internal mechanisms, external support, and policy interventions [6]. In this context, Augmented Reality (AR) has the potential to be an instrument capable of re-articulated the concept of rural social space into a dynamic, interactive, and participatory digital space.

2.2 Augmented Reality and Digital Spatial Experiences

AR technology has become a significant catalyst in creating new spatial experiences in rural areas. Lv demonstrated that the application of AR in rural landscape design not only enhances visual quality but also strengthens citizen engagement in spatial planning [27]. Through interactive visualizations, the public can understand spatial changes and contribute directly to the design process.

Rauschnabel added that AR creates immersive spatial experiences by simultaneously combining physical and digital realities [10], resulting in enhanced environmental perception and social engagement.

Furthermore, Guo utilized a combination of LiDAR and UAV photogrammetry to generate high-precision 3D spatial models that support the preservation of historic wooden architecture in rural areas [28]. This spatial data integration demonstrates that AR can function as a medium for cultural documentation and conservation. Furthermore, research by Aiswerya and Jawhar and Novickis demonstrated significant advances in spatial computing, with the development of the Siamese Capsule Network and spatial transformation accelerator enabling real-time spatial rendering [29], [30].

From this literature, it can be concluded that AR functions not only as a visualization tool but also as a connecting technology between digital and social spaces, facilitating interactivity, collaboration, and equity in rural spatial experiences.

2.3 Digital Innovation and Rural Sustainable Development

Digital innovation has been recognized as a key driver of rural sustainable development. Wiendl and Kreuziger, using the Smart Countryside Framework, assert that the success of digital village development is measured not only by the level of technology adoption [31], but also by the extent to which digitalization increases citizen participation and spatial equity. Omer reinforces this idea by highlighting the importance of digital planning as a mechanism for expanding public access to spatial planning and public policy [32].

In an economic context, Wang and Effendi found that digitalization of agricultural supply chains and digital collaboration among citizens can strengthen village economic resilience [33], [15]. Research by Zambon and Tian added that digitalization plays a crucial role in strengthening the creative economy and ecotourism [14], [16], where AR becomes an instrument for interactively displaying local cultural and ecological values.

These findings confirm that digitalization is not only transforming the economic aspect but also shifting the development paradigm to be more inclusive and sustainable.

2.4 Digital Literacy and Community Empowerment in Rural Areas

The digital divide is a major challenge in realizing equitable and inclusive smart villages. Various studies show that improving digital literacy is a key prerequisite for the success of technological innovation in rural areas. Fahmi and Arifianto explain that digitalization can stimulate social innovation through cross-community collaboration that improves communication and management of local resources [18].

Zerrer and Sept introduced the concept of smart villages, which positions communities as the primary agents of social change through the use of technology [19]. Stojanova added that digital innovation hubs function as shared learning spaces that strengthen community social and economic capacity [21].

Zhang and Li and Zhou demonstrate that digital finance and inclusive technology can expand financial access, improve community welfare, and reduce social disparities [20], [34]. Thus, digital literacy is not merely a technical skill but also a social empowerment mechanism that enables village communities to play an active role in digital development.

2.5 Theoretical Model of AR Integration in the Village Socio-Spatial Context

Interdisciplinary studies on AR demonstrate the emergence of a conceptual model that combines theories of social technology (social shaping of technology) with spatial planning. Akbar demonstrate that AR can be a participatory tool for integrating local knowledge into village planning processes [22].

Wismantoro demonstrate how AR enriches ecotourism experiences and environmental awareness through digital interactions [23]. Bravo highlight AR's potential to strengthen social innovation and open new economic opportunities at the community level [24], while Septiyarini emphasize AR's role in increasing public participation and transparency in village governance [25].

From this literature, a conceptual model of AR-Driven Rural Spatial Transformation was developed, encompassing three main components: (1) Spatial Transformation – transforming physical space into a participatory digital one; (2) Digital Empowerment – strengthening the socio-technological capacity of village communities; and (3) Spatial Justice – equitable access to the benefits of digital development.

This model positions AR not merely as a visualization technology, but as a tool for the production of social space and an instrument of spatial justice in the context of sustainable village development.

Based on the overall literature, it is understood that the transformation of village space through AR is a multidimensional process encompassing:

Table 1. Literature Analysis Based on the Dimensions of Village Space Transformation through AR

No.	Dimension	Author(s) & Year	Research Focus	Main Findings	Relevance to This Study
1	Spatial	[27], [28]	Application of Augmented Reality (AR) and spatial technologies (LiDAR, UAV) in rural landscape design and cultural documentation.	AR creates a new spatial experience by merging physical and digital spaces, enabling communities to understand spatial changes interactively. UAV–LiDAR technologies support the preservation of rural architecture and cultural heritage.	Demonstrates that rural spatial transformation occurs through digitalization and spatial interactivity, forming a <i>hybrid spatial experience</i> as the foundation for new digital space production.
2	Social	[22], [31]	Digitalization of rural social spaces through citizen participation (<i>co-design</i>) and the use of AR in participatory spatial planning.	Communities become key actors in digital planning; AR technologies enable collaboration and <i>visual participation</i> in development processes. The <i>Smart Countryside Framework</i> emphasizes <i>spatial justice</i> and <i>digital inclusion</i> .	Indicates that digital technology and AR reshape rural social structures toward greater participation and inclusivity, aligning with the concept of <i>digital empowerment</i> .

3	Economic	[15], [33]	Rural economic transformation through digitalized agricultural supply chains and AR-based community collaboration.	Digitalization enhances efficiency, transparency, and sustainability in rural economies. AR strengthens village collaboration models and expands market access through the digital economy.	Reinforces that AR-based digital innovation acts as a catalyst for achieving <i>rural modernization</i> and an <i>inclusive digital economy</i> as the foundation for sustainable rural development.
4	Ecological	[23], [35]	Utilization of AR in eco-tourism and environmental preservation; integration of digital economy systems for sustainable resource management.	AR fosters ecological awareness through immersive and educational experiences; digital technologies optimize resource use and promote <i>eco-friendly tourism</i> .	Confirms that AR supports sustainable rural development by integrating ecological awareness and environmental conservation through immersive technologies.

Thus, the literature reviewed indicates a paradigm shift from rural modernization to rural digital transformation, where Augmented Reality serves as a bridge between humans, technology, and sustainable living spaces.

Research Methodology

This study uses a Narrative Literature Review (NLR) approach with the aim of examining, synthesizing, and interpreting scientific literature that discusses the relationship between Augmented Reality (AR), rural spatial transformation, and sustainable development. This approach was chosen because it is able to explain conceptual and theoretical developments in depth without rigid methodological limitations as in a Systematic Literature Review. The research data is secondary, obtained from reputable journal articles, academic books, scientific proceedings, and reports from international institutions such as UN-Habitat and the World Bank, published between 2015 and 2025. The literature collection process was carried out through the Scopus, ScienceDirect, SpringerLink, and Scite.ai databases, using a combination of keywords such as "Augmented Reality" AND "rural development", "digital innovation" AND "spatial transformation", and "rural modernization" OR "spatial justice". Inclusion criteria include literature relevant to the theme of digital innovation-based rural development, while non-scientific articles and publications that do not have a strong methodological basis are excluded. Data analysis was conducted using narrative thematic analysis, with three main stages: open coding to identify key concepts, axial coding to group themes such as spatial transformation, digital inclusion, AR experience, community empowerment, and sustainable rural development, and selective coding to construct a conceptual narrative that illustrates the relationships between themes. This approach allows for cross-disciplinary interpretation of technology, spatial planning, and development studies. The validity and reliability of the analysis were ensured through conceptual and source triangulation, comparing results from various disciplines and confirming findings with global institutional reports. Because all data were sourced from open publications, this study did not require participant ethics approval, but all sources were cited according to IEEE style to maintain academic integrity and avoid plagiarism. Methodological steps are detailed to ensure replication by other researchers. The expected outcomes of this study are a conceptual synthesis explaining the role of AR in rural socio-spatial transformation, the development of an integrative theoretical model linking digital innovation with spatial justice and sustainable development, and the establishment of a future research agenda on the application of immersive technology in the context of inclusive and equitable rural development.

Results

4.1 Digital Spatial Transformation and the Production of New Spaces

A literature review shows that digitalization has transformed the concept of rural space from a physical entity into a hybrid entity that combines social, virtual, and interactive dimensions.

Lv emphasized that Augmented Reality (AR) technology can transform the perception and experience of rural space through interactive digital landscape visualizations [27]. In the context of rural revitalization in China, the use of AR allows communities to directly participate in the landscape design process, creating a new form of co-creation of space that is more participatory and inclusive.

Research by Guo supports these findings by highlighting the integration of LiDAR and UAV photogrammetry in the preservation of historic architecture [28]. This technological integration produces high-precision three-dimensional spatial models that enable the digital reinterpretation of physical space, reinforcing conservation values and local identity.

In terms of technical aspects, Novickis introduced a Field Programmable Gate Array (FPGA)-based spatial transformation accelerator that enables highly efficient parallel spatial processing [30]. This innovation demonstrates that spatial transformation is now not only conceptual but also relies on sophisticated digital spatial data processing technology. Aiswerya and Jawhar complement this finding with the development of a Siamese Capsule Network for real-time spatial detection that can be applied in AR systems in the context of smart rural mapping [29].

Overall, the literature synthesis shows that rural space is no longer understood solely in physical terms, but as a digital-interactive entity produced through collaboration between humans, data, and technology. Thus, the spatial transformation process is both social and digital—a new form of multi-layered space production.

4.2 Digital Innovation as a Driver of Sustainable Rural Development

The second theme highlights the central role of digital innovation in driving sustainable rural development, particularly through the application of the concepts of smart countryside, digital governance, and the rural creative economy.

Wiendl and Kreuziger proposed the Smart Countryside Framework in Germany [31], which emphasizes the importance of digital co-design between communities, local governments, and technology developers. Through this approach, digitalization is not merely infrastructure modernization, but also a social process that creates spatial justice and digital inclusion.

Similarly, Omer emphasized that digital planning can expand public access to spatial planning, reduce spatial inequality, and increase transparency in rural governance [32].

In an economic context, Effendi demonstrated that digital collaboration through technologies such as AR and IoT can strengthen village enterprise models and increase residents' economic resilience [15]. Research by Wang added that the digitalization of agricultural supply chains acts as a catalyst for green innovation [33], boosting productivity and sustainability. Zambon and Tian highlighted the role of AR and digital technology in strengthening the village creative economy and eco-tourism [14], [35], which directly contribute to sustainable development and the preservation of local identity.

These results demonstrate that digital innovation serves as an integrative driver for rural development—connecting the local economy, ecology, and technology within a single, sustainable system.

4.3 Community Empowerment and Rural Digital Literacy

The literature also demonstrates the important role of digital technology in strengthening the social capacity and technological literacy of rural communities.

Fahmi and Arifianto explain that digitalization can trigger social innovation by improving communication and collaboration between communities [18], particularly in the management of local resources. Zerrer and Sept introduce the concept of smart villages, emphasizing community-based digitalization as a means to address demographic challenges and limited public services in rural areas [19].

Research by Stojanova adds that digital innovation hubs function as centers for collaborative learning and technological empowerment [21], encouraging residents to use digital tools productively in economic and social activities.

Zhang and Li & Zhou demonstrate that digital finance can strengthen rural economic inclusiveness by opening access to modern financial services [20], [34].

Overall, this literature confirms that digital empowerment is a crucial foundation for sustainable rural development, where AR and other digital technologies serve as a medium for literacy, collaboration, and social inclusivity.

4.4 Socio-Spatial Integration and Conceptual Models of Augmented Reality

Analysis of interdisciplinary literature indicates an emerging trend towards integrating social and spatial theories in the use of AR for village development.

Akbar demonstrate how AR can be used in participatory planning by directly involving communities in spatial decision-making processes through interactive visualizations [22].

Wismantoro highlight the potential of AR in eco-tourism [23], strengthening local environmental and sustainability awareness through immersive experiences. Bravo assert that the application of AR can stimulate social innovation and create new economic opportunities based on local potential [24].

Septiyarini add a political dimension by demonstrating that AR can increase transparency and participation in village governance through an interactive visualization system for public policy [25]. Lorusso and Flores-Castañeda expanded this perspective by demonstrating that AR is not only informative but also educational—supporting social learning and spatial understanding for rural communities [12], [13].

These findings led to the development of a new conceptual model, the AR-Driven Rural Spatial Transformation Model, which combines three main components: (1) Spatial Transformation (transforming physical-digital space); (2) Digital Empowerment (strengthening community capacity through technology); and (3) Spatial Justice (equitable access and distribution of technological benefits).

4.5 Overall Synthesis Findings

Based on the analysis of the entire literature, four main empirical conclusions were obtained: (1) Augmented Reality reconstructs rural spaces into interactive digital spaces that enable new spatial experiences based on citizen participation; (2) Digital innovation and immersive technology act as catalysts for sustainable development through economic, social, and ecological transformation of villages; (3) Digital literacy and social inclusiveness are key factors in the success of village digital transformation, linking technology with community empowerment; and (4) Socio-spatial integration through AR gives birth to a new conceptual model that positions technology as a means of spatial justice, not just a technical instrument.

Discussion

5.1 Integration of Spatial Transformation Theory and Digital Spatial Production

The findings of this study confirm that the concept of rural spatial transformation in the digital era cannot be separated from Lefebvre's theory of spatial production and its reinterpretation in the context of rural modernization. Lefebvre argued that space is a social

construct produced through the relationship between social practices, symbolic representations, and spatial imagination [3]. In this context, Augmented Reality (AR) extends this concept into a form of digital spatial production, where the interaction between physical and virtual spaces creates a new experience called hybrid space.

Lv shows how AR revolutionizes rural spatial design through the visual participation of residents [27], enabling collaborative space reproduction. This demonstrates that rural space is no longer passive but rather a vibrant and responsive arena for digital interaction. The integration of AR in this context expands Lefebvre's understanding by adding a technological dimension as a new agent in the production of social space, thus emerging the concept of digital spatiality, which serves as a new analytical basis for rural development in the 4.0 era.

5.2 Digitalization as a New Mechanism for Spatial Development

From a sustainable development perspective, digitalization acts as a new mechanism for creating social, economic, and spatial connectivity in rural areas. Wiendl and Kreuziger, through their Smart Countryside Framework [31], demonstrate that digitalization is not simply the application of technology but also a social engineering strategy that positions residents as co-designers of village development. This creates a new form of spatial citizenship where residents become not only beneficiaries but also creators of digital space.

Omer reinforces this view by explaining that digital planning can reduce spatial inequality through open access to information and increased transparency of development policies [32]. Thus, digital innovation fosters what is known as spatial justice—equity in access to space, information, and development opportunities. AR, in this context, functions as an epistemic bridge that connects data-driven planning with the spatial experiences of villagers, making development more adaptive, participatory, and equitable.

5.3 Augmented Reality as a New Socio-Spatial Medium

The synthesis of these results demonstrates that AR functions not only as a visual technology but also as a new socio-spatial medium that connects individuals with their communities and environments. Guo demonstrated this by utilizing AR technology combined with UAVs and LiDAR to document cultural heritage in rural areas [28]. This technology enabled people to interact with spatial representations in an immersive manner, while preserving their historical and cultural value.

Meanwhile, Novickis demonstrated that efficient digital spatial transformation can be achieved through a spatial transformation accelerator [30], which enables parallel processing of spatial images with high precision. This technological integration creates a new form of digital social space that is more real-time and data-driven. This reinforces the view that AR functions as a social medium that expands the boundaries of space and time and fosters more active engagement between citizens and their environments.

5.4 AR, Digital Innovation, and the Sustainable Economic Dimension

Economically, AR and digital innovation have been shown to contribute to improving rural welfare by expanding market access, strengthening ecotourism, and supporting the local creative economy. Effendi demonstrated that digital collaboration among villagers through an AR-based platform can increase the effectiveness of micro-enterprises and strengthen local economic resilience [15]. Zambon and Tian also emphasized that the application of digital technology can accelerate rural economic transformation based on green innovation and the creative economy [14], [35], where AR serves as a means of promotion, education, and cultural preservation.

Furthermore, Wang demonstrated that the digitalization of agricultural supply chains enables increased efficiency and ecological sustainability [33], in line with Sustainable Development Goals (SDGs) points 9 and 11. In this context, AR is not simply a visualization

tool, but also a socio-economic infrastructure that connects the agricultural, tourism, and creative economy sectors within a rural digital ecological system.

5.5 Empowerment and Digital Literacy as the Basis for Transformation

Community empowerment is the primary foundation for successful rural digital transformation. Fahmi and Arifianto demonstrate that digitalization can create new social innovations through cross-community communication and collaboration [18], which strengthens citizen participation in development activities. Zerrer and Sept emphasize that successful smart villages are not the most technologically advanced [19], but rather the most socially adaptive. Stojanova support this view by highlighting the importance of digital innovation hubs as a platform for community learning and collaboration [21].

Li, Zhou and Zhang expand on this idea by demonstrating that increasing digital literacy and access to digital finance can reduce economic disparities [20], [34], strengthen social inclusiveness, and increase citizen participation in the digital economy. Thus, digital empowerment is an essential element in transforming the social structure of villages from a passive society to an innovative one (a digitally-empowered rural society).

5.6 Integration of Social and Spatial Theories in the AR Model

The integration of social shaping of technology and spatial planning theory produces a new conceptual model called the AR-Driven Rural Spatial Transformation Model. Akbar demonstrate that the use of AR in participatory planning can strengthen local knowledge and expand citizen involvement in the planning process [22]. Wismantoro add that AR-based immersive experiences in ecotourism strengthen residents' ecological awareness [23], making the technology both a reflective and educational tool.

Bravo and Septiyarini demonstrate that AR can expand villagers' political participation in public space governance, while increasing government transparency [24], [25]. Through this framework, AR is no longer understood simply as a representational technology, but as a social engineering tool capable of integrating spatial, social, and political dimensions in the village development process.

5.7 Academic Significance and Scientific Contribution

This research makes an important academic contribution by extending the theory of spatial transformation into the digital realm through the integration of Augmented Reality and rural development studies. First, this research introduces a new paradigm that village space is now the result of interactions between physical, social, and digital entities. Second, this research strengthens the concept of spatial justice by positioning technology as a means of equalizing access, rather than as a source of new inequalities. Third, this research produces a conceptual model, the AR-Driven Rural Spatial Transformation Model, that can be used as a theoretical foundation for further studies on village digitalization and sustainable development. Thus, this research contributes to the formation of a new epistemic framework in digital rural studies that integrates spatial, social, and technological dimensions.

5.8 Policy Implications and Future Research Agenda

The practical implications of this research are broad. In the context of public policy, the results demonstrate the need to integrate village digitalization policies with sustainable development strategies and equitable access to technology. Local governments need to encourage the application of AR in spatial planning, education, and community-based tourism. Furthermore, it is crucial to develop rural innovation labs as centers for research and collaboration between academics, government, and village communities.

Academically, this research opens up opportunities for further study of the socio-technical impacts of AR on spatial structure, social behavior, and local economic dynamics.

Future studies could empirically test the models developed through digital ethnography, participatory design research, or spatial simulation modeling approaches. Thus, this research not only provides a conceptual contribution but also offers strategic direction for inclusive and sustainable digital village development policies.

Conclusion

This study concludes that Augmented Reality (AR) technology plays a strategic role in transforming rural spaces into inclusive, collaborative, and sustainable digital spaces. Using a Narrative Literature Review approach to 17 international scientific literature, this study found that the transformation of rural spaces is not only a physical process, but also a social and digital one involving interactions between technology, society, and the environment.

First, AR reconstructs the spatial experiences of rural communities by combining physical and virtual spaces. This creates a new form of hybrid space where residents can actively participate in the design, planning, and management of their own spaces [27], [28]. Second, digital innovation strengthens sustainable development by increasing economic efficiency, expanding access to information, and promoting spatial justice through digital governance [31], [32]. Third, digital empowerment is the main foundation of rural social transformation, where technological literacy and community collaboration play a crucial role in creating adaptive and resilient villages [18], [21].

Furthermore, this study develops a conceptual model of the AR-Driven Rural Spatial Transformation Model, which integrates three main pillars: (1) spatial transformation (changing spatial form and social function); (2) digital empowerment (strengthening community technological capacity), and (3) spatial justice (just distribution of technological benefits).

This model demonstrates that the success of rural digitalization depends on a balance between technological innovation and socio-ecological justice.

In terms of scientific contribution, this study extends the theory of spatial transformation and the social shaping of technology to the context of sustainable rural development. These findings strengthen AR's position as a new epistemic instrument in spatial studies and enrich the conceptual framework of digital rural studies with its intertwined social, economic, and political dimensions.

Research and Policy Recommendations

Several important recommendations are made for future research and policy development. First, empirical and longitudinal studies are needed to test the conceptual model developed in this research using participatory spatial analysis and digital ethnography in various rural areas. This approach will strengthen the empirical validity of the influence of AR on the formation of village social and economic space.

Second, the government and development institutions need to integrate village digitalization policies with sustainable development strategies. The development of rural digital labs and AR-based spatial innovation centers will help accelerate knowledge transfer and strengthen the technological capacity of rural communities.

Third, in an academic context, it is recommended that future research expand exploration of the role of immersive technologies (AR, VR, and digital twins) in building participatory and inclusive spatial planning. This is crucial to ensure that digital transformation not only creates new spaces but also strengthens values of social, ecological, and cultural justice.

Thus, this research confirms that transforming village space through AR is a path towards sustainable development rooted in participation, inclusivity, and spatial justice. AR is not only a technology of the future, but also a social medium capable of re-establishing the relationship between people, space, and sustainability in rural areas.

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