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Digital Transformation in Rural Areas: Directions for Digital Village Development in Developing Countries

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Abstract

This research investigates the development of digital villages in developing countries, focusing on the challenges and opportunities in implementing Information and Communication Technology (ICT) to improve the quality of life and socio-economic conditions in rural areas. The objectives of this study include identifying the key challenges and opportunities in digital village development, exploring how ICT can enhance rural livelihoods, and proposing a model for effective, innovative technology implementation in rural settings. A systematic literature review was conducted, analyzing 867 articles from the Scopus database between 2015 and 2025. The RStudio application was used to analyze the data and visualize publication trends, collaboration patterns, and key themes related to digital village development. The findings highlight that while digital villages can potentially reduce the rural-urban divide, challenges such as insufficient digital infrastructure, low digital literacy, and limited government policies hinder progress. However, successful cases like China's Digital Village initiatives demonstrate that ICT-driven innovation can drive substantial improvements in rural areas with supportive government policies and active community participation. This study contributes to the existing literature by emphasizing the integration of social, cultural, and economic factors in adopting digital technologies and by promoting sustainable innovation ecosystems that empower rural communities. Limitations include focusing on a few developing countries and relying on published articles, which may not fully capture the nuances of rural

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technology implementation in resource-constrained environments. Future research should include case studies from diverse regions and examine the role of government policies in accelerating the adoption of digital village models. This research recommends a more inclusive and innovation-oriented approach to digital village development, incorporating technological infrastructure and the empowerment of local communities through digital literacy programs and public-private sector collaboration.

Keywords: Digitalization Government, Information and Communication Technology, Sustainable Development, Innovative Village Development

INTRODUCTION

Digital transformation in rural areas of developing countries is imperative to bridge the urban-rural divide, increase agricultural productivity, and promote sustainable development. The positive impact of digital infrastructure and finance on rural revitalization in China (Bi, 2024), the potential of innovative village strategies in the European Union (Cāne, 2021), and the transformative role of information and communication technology (ICT) in agriculture in Indonesia support this assertion (Wijaya et al., 2020).

The development of smart villages in developing countries is defined as the application of ICT to improve the quality of life and empower rural communities in various aspects of life, from the economy to education and public services (Subanda & Dewi, 2024). Smart villages leverage digital devices and infrastructure to create a more connected, sustainable, and inclusive environment. This technology is used to optimize natural resource management, accelerate access to information, and improve the efficiency of the agriculture, health, and education sectors (Rohan et al., 2022). The main goal of the development of smart villages is to bridge the digital divide between villages and cities, thereby increasing the competitiveness of rural communities in the digital era (García Fernández & Peek, 2023).

Although much research discusses the application of technology in urban areas, little research focuses on developing smart villages in developing countries. This gap in literature results in a lack of in-depth understanding of how technology can be adapted and applied in rural contexts as distinct from urban contexts. This gap in literature results in a lack of in-depth understanding of how technology can be adapted and applied in rural contexts as distinct from urban (Menon et al., 2024). Most of the existing literature focuses on technical and infrastructure aspects, while only a few examine the social, cultural, and economic factors that influence the acceptance and success of technology in such an environment (Oh & Bhatia, 2024). To address these issues, this research seeks to answer two key questions: (1) What are the main challenges and opportunities in developing smart villages in developing countries? (2) How can ICT and other technological innovations be implemented in rural areas to improve community life and economic conditions?

This research effort must include studies on the digital literacy of rural communities, the role of government policies, and community empowerment strategies in the context of technological change (Setiansah et al., 2024). In addition, it is very important to design simpler and more affordable technological solutions that are suitable for the existing infrastructure conditions in the village. To achieve this goal, collaborative efforts are needed between the public, private, and community sectors, with the ultimate goal of creating smart villages that not only prioritize technological advancement, but also strengthen the social and economic capacity of village communities (Buyannemekh et al., 2023).

The impetus for the development of smart villages in developing countries stems from the urgent need to bridge the social and economic gap between rural and urban areas. The digitalization process in these villages involves not only the application of technology, but also the empowerment of the community to manage and maintain the technology independently and sustainably (Bi, 2024). The main motivation of the research is to explain how technology can change the way village communities interact with the outside world, access information, and optimize their local potential (K. R. & R., 2021). Therefore, this research seeks to provide technology-based solutions that can empower rural communities, increase access to basic services, and create more equitable economic opportunities.

The purpose of this research is to examine the challenges and opportunities in developing smart villages in developing countries, focusing on implementing Information and Communication Technology (ICT) and other technological

innovations. Specifically, this study aims to identify the key challenges and opportunities in applying ICT to rural areas and explore how these technologies can improve these communities' quality of life and economic conditions. Additionally, the research seeks to propose a practical technology implementation model tailored to the socio-economic realities of rural settings to foster inclusive and sustainable smart villages. This study will contribute to bridging the digital divide and enhancing the socio-economic empowerment of rural populations in developing countries.

A new aspect of this research is a more holistic approach to the discussion of smart village development, which integrates social, cultural, and economic factors in the application of technology (Zavratnik et al., 2020). This research introduces the concept of "inclusive smart villages", which not only focuses on technological infrastructure, but also on empowering rural communities through increasing digital literacy and active participation in decision-making. Therefore, this research makes a new contribution to the existing literature on the development of smart villages in developing countries. In addition, the study also offers a more contextual and affordable solution for countries with limited resources (Setiansah et al., 2024).

METHOD

To ensure methodological rigor and transparency, this study adopted the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach in documenting the literature selection process. This structured framework allows for a systematic identification, screening, and inclusion of relevant studies, thereby enhancing the reliability and reproducibility of the research findings.

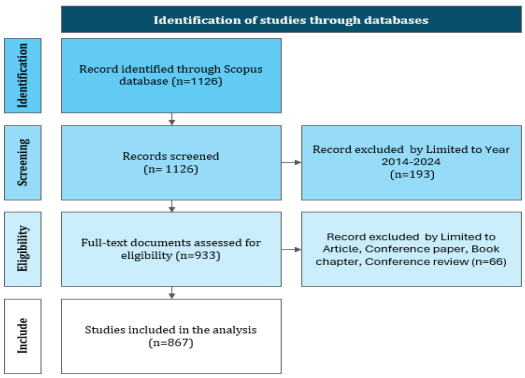

Figure 1. The modified PRISMA diagram illustrates the process of selecting articles in a systematic review.

Figure 1 shows the PRISMA method of the selection process carried out in this study, starting with the identification of 1,126 documents found through the Scopus search database for the years 2014 to 2024, then all 1,126 documents were selected, and 193 documents were issued because they did not meet the criteria for the relevant year (2014-2024). The next stage is the eligibility stage, where the remaining 933 documents are further evaluated to ensure their eligibility for inclusion in the analysis. At this stage, 66 documents were issued due to their nature, including articles, conference papers, book chapters, and conference reviews, which did not meet the criteria for analysis.

The data for this study were retrieved using a systematic search strategy within the Scopus database, focusing on publications related to the development of smart villages, digital villages, and ICT in rural areas. The following search string was used to ensure the inclusion of relevant articles: TITLE-ABS-KEY (digital AND transformation) AND TITLE-ABS-KEY (rural AND development) AND TITLE-ABS-KEY (smart OR village OR technology) AND TITLE-ABS-KEY (developing AND countries).

In the final stage, a total of 867 studies were selected to be included in the analysis, which would be the basis for systematic insights or meta-analysis. This flowchart shows a transparent and systematic approach to selecting relevant studies, ensuring that only documents that meet the eligibility criteria are used for further analysis. This meticulous process is crucial in upholding the validity and rigor of the research, thus ensuring reliable results and their alignment with the broader context of the subject.

RESULT AND DISCUSSION

Publication Trends and Collaboration Maps

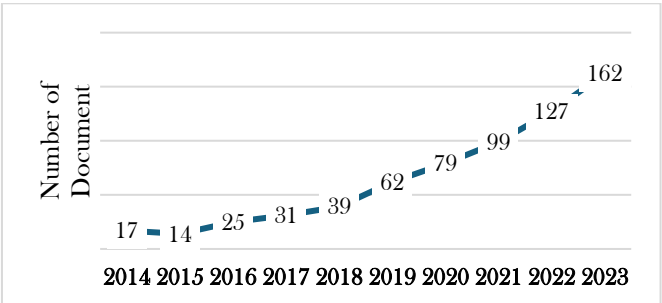

Figure 2: Trend in the number of publications

Figure 2 shows a noticeable trend of increasing publications in the number of publications from year to year, with a very noticeable spike in 2022 and 2023. From 2014 to 2019, the number of publications was

still relatively low, ranging from 14 to 39 publications per year. However, in the 21st century, a significant breakthrough appeared, marked by a substantial jump in publications in 2020 to 79, and a remarkable increase to 162 in 2023. This striking increase signifies a tremendous enthusiasm and commitment to the subject of digital villages, which may be driven by digital and global technological advancements, contributing to digital transformation in rural areas (W. Zhao et al., 2022).

The proliferation of publications in the realm of digital village development, which includes subjects such as information and communication technology (ICT) integration, digital empowerment, and digital-based economic development in rural areas, reflects the acceleration of progress in this field (Choudhary et al., 2021). This development is related to efforts aimed at realizing the concept of "smart villages", which utilize digital technology to improve the quality of life of rural communities, reduce the digital divide, and promote social and economic sustainability. the adoption of ICT in rural development not only facilitates economic growth, but also encourages a more inclusive social transformation (Zavratnik et al., 2018).

This increasing trend of publications is inseparable from the increasing international collaboration and multidisciplinary research involving various sectors, such as technology, economics, and social sciences. In this context, research related to digital villages is becoming increasingly relevant and makes a significant contribution to achieving the Sustainable Development Goals (SDGs), especially in overcoming poverty and development disparities (Sampetoding et al., 2024). The integration of digital technology into village development strategies can accelerate socio-economic transformation, reduce poverty, and improve access to education and health services. This study shows that although there are still challenges, the potential for positive change through the development of digital villages is quite significant, as evidenced by the increasing number of publications in this field (Bhosale et al., 2023).

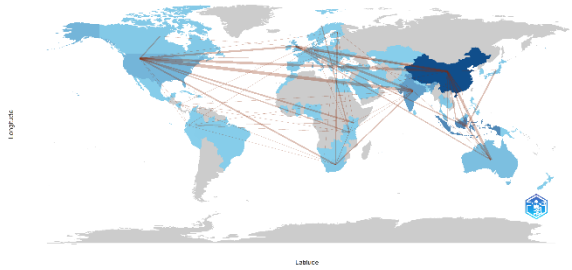

Figure 3. Collaboration Map

Figure 3 shows a map of the country's collaboration depicting the interconnectedness of global relations, with China as the main center of international collaboration related to the development of digital villages. This map shows how countries around the world, including countries in Asia, Europe, the Americas, and Africa, are interconnected through collaboration pathways. These pathways demonstrate cooperation in research, development, and implementation of technology for smart villages. Notable participants in this effort include India, the United States, several European countries, and Australia, underlining a marked escalation in global efforts to drive digital transformation in rural areas (Cao et al., 2023).

China's role in this collaborative effort is very dominant, in line with the country's status as a pioneer in the field of digital technology and infrastructure development, especially in the context of digital village development. China has initiated several important programs with the aim of encouraging the development of smart villages, using the Internet of Things (IoT), big data, and information technology to improve the quality of life of rural communities (Mei et al., 2022). The People's Republic of China has initiated several smart village projects, the success of which has been proven by their success in improving village infrastructure, empowering professionals in agriculture, and accelerating the integration of digital technology into rural daily life (Lai et al., 2024).

In addition, an examination of the collaboration map shows that countries with advanced technological capabilities, such as the United States and European countries, play an important role in providing research, resources, and policy support that facilitates the implementation of smart villages (Maja et al., 2020). This growing international collaboration underscores the idea that digital village development is not only a national priority, but also a global agenda. This is very important because the achievement of the Sustainable Development Goals (SDGs) that result in poverty reduction and improvement of the quality of life in rural areas depends on the advancement of technology (Aparicio-Gómez et al., 2024). This investigation reveals that international collaboration in the development of digital villages in Asia has the potential to accelerate the adoption of new technologies and help create inclusive and sustainable development models in rural areas. (H. Wang & Tang, 2023).

Most Influential Themes and Topic Trends of Smart Villages in Developing Countries

The research on these trends and issues includes an in-depth study of smart villages in developing countries, with the aim of identifying important patterns and shifts in research emphasis. Within the framework of literature review analysis, this process includes monitoring contemporary developments in publications, identifying new technologies and strategic approaches, and evaluating issues that arise along with the development of science and technology. By understanding these trends, we can shed light on emerging areas and address critical issues that hinder scientific progress and their practical application.

Figure 4. The topic of the emergence of Smart Villages in developing countries

Figure 4 shows the focus on digital villages and smart villages as part of technology-based village transformation. Rural Development & Rural Revitalization: These concepts illustrate the concept of rural development and revitalization through digital approaches and innovations (W. Zhao et al., 2022). Digitalization & Digital Transformation: These concepts describe the process of change based on digital technology applied in the rural sector. Sustainable Development These concepts describe the integration of technology with sustainability as the goal of digital village development (Haktanır et al., 2023).

In developing digital villages, challenges remain, particularly in China, where regional disparities in infrastructure and economic development hinder the effectiveness of digital transformation. Studies, such as (P. Wang et al., 2023), reveal that while digital village initiatives have fostered entrepreneurship, their impact on broader economic growth and innovation has been limited, especially in rural, agricultural areas. These challenges emphasize the need for more tailored approaches that address specific regional needs and promote innovation-driven strategies to ensure equitable and sustainable development. Additionally, the disparity in digital village success between non-agricultural and agricultural counties highlights the importance of context-specific solutions to realize the potential of digital technologies in rural areas fully.

In relation to the development of digital villages, various technologies have been mentioned in the word cloud, including the Internet of Things (IoT) These technologies are used to improve efficiency in agriculture, environmental monitoring, and village resource management (Chanak & Banerjee, 2021). Geographic Information System (GIS)This is used for mapping technology in village spatial planning. Artificial Intelligence (AI) and Machine Learning It is used for the implementation of artificial intelligence in village data analysis (Sholarin & Awange, 2015). Big Data and Remote Sensing is used for large-scale data utilization for better decision-making. Finally, the digital economy and e-commerce are other major areas of transformation, which offer significant potential for economic development in rural communities through e-commerce and the digital economy (Lai et al., 2024).

In addition to technological aspects, social and economic dimensions are also considered in the development of digital villages (Agusta, 2023). These dimensions include Digital Literacy & Digital Inclusion. This is the readiness of village communities to adopt digital technology. Digital Divide, Digital access gap between urban and rural areas (Lu et al., 2024). Social Capital & Community Development, this is the empowerment of village communities to increase their digital capacity. E-commerce & Rural Digital Marketing It is the use of digital platforms to increase the competitiveness of village products in the global market (Avazpour et al., 2024).

An analysis of the word cloud in the case area reveals that the concepts of digital villages and smart villages have been widely applied in various countries. These countries include China and India, countries that have witnessed great progress in technology-based village transformation (Zhang et al., 2023). Indonesia is a country that shows evidence that this concept is also developing (Renanti et al., 2024). Taobao Village is a well-known e-commerce-based digital village model in China, which shows success (Tang & Zhu, 2020). This image reflects the importance of digital transformation in the context of rural development, which emphasizes the use of technology to improve sustainability, digital inclusion, and economic and social growth in rural areas. The word cloud accompanying the image further underscores the idea that the concept of smart villages and digital villages is more than just

technological infrastructure, which includes aspects such as community empowerment, digital policy, and collaboration among relevant stakeholders (Belikova et al., 2024).

Table 1. Smart Village Topic Trends in Developing Countries

Term	Frequency	Year (Q1)	Year (Median)	Year (Q3)
Smart Village	41	2021	2022	2023
Digital Village	35	2022	2023	2024
Rural Development	26	2021	2023	2024
Digitalization	21	2021	2022	2023
Rural Revitalization	21	2022	2023	2024
Digital Divide	19	2018	2022	2024
Cultural Heritage	17	2019	2021	2023
Sustainable Development	17	2023	2024	2024
ICT	15	2018	2021	2023
GIS	14	2018	2019	2022

Table 1 shows the trends of the dominant themes related to digital village development, which is indicated by the frequency of occurrence of each term and the prediction of trends for the coming years. Based on the data, the most dominant theme is 'smart villages' with the highest frequency of 41, which reflects the great interest in the application of technology in smart village development. In addition, 'digital villages' and 'rural development' also show significant trends with frequencies of 35 and 26 respectively. Both terms show a strong interest in using digital technologies to improve the quality of life in rural areas and to accelerate economic and social development in these areas (Cen et al., 2022). Projections for 'smart villages' show that this topic will continue to dominate in 2023 and 2024, indicating that discussions on smart villages will remain a key focus of research and development policy at the global level (Doloi et al., 2022).

In this case, technological advances such as the Internet of Things (IoT), big data, and geographic information systems (GIS) are very important in the implementation of smart villages. Smart villages integrate a variety of technological innovations to address the challenges of rural development, including access to basic services, improving the agricultural sector, and reducing the digital divide (Sheyhova & Safonova, 2024). The study found that smart villages in China have successfully improved the efficiency of agricultural management and improved the quality of life of rural residents through the adoption of digital technologies, such as smart sensors and cloud-based platforms, so that the increase in publications on smart villages is in line with the expansion of technologies supporting the development of digital villages around the world (V et al., 2021).

The topic of "digitalization", which ranks fourth with a frequency of 21, is also becoming more prominent, indicating that the digitalization process is a key step in the development of digital villages, which includes digital transformation in various sectors, including education, health, and public services in rural areas. In contrast, the terms "sustainable development" and "rural revitalization" each recorded a frequency of 17 times, underscoring the importance of a sustainable approach to digital village development. This approach emphasizes not only the integration of technology, but also the improvement of the quality of life and effective management of natural resources. The implementation of digitalization with a sustainability-based approach in rural areas can contribute to inclusive economic growth and the reduction of the gap between urban and rural areas. Therefore, the integration of digitalization and sustainable development is an important aspect in creating an advanced and competitive digital village (Kasimov et al., 2021).

Map of the Conceptual Structure of Mapping and Topic Evolution

Topic mapping is a scientific analysis method used to identify, visualize, and understand relationships and structures in research literature. Through this technique, researchers can explore the interconnectedness of different topics and the evolution of various research trends. They can also identify key trends and patterns and explain the existence of cluster topics that often appear together in scientific publications.

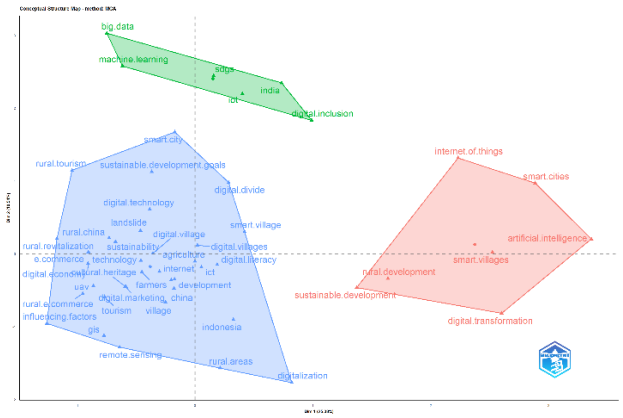

Figure 5. Conceptual Structure Map

The initial cluster, depicted in blue, includes smart villages, digital villages, rural development, sustainability, agriculture, digital economy, and remote sensing. This cluster underlines the integration of digital technology in agriculture, rural economy, and environmental sustainability. The concepts of 'smart villages' and 'digital villages' signify initiatives to build rural communities that adopt technological solutions to improve the quality of life of their residents, with a special emphasis on facilitating access to information, promoting digital product marketing, and improving agricultural efficiency (Gómez-Carmona et al., 2023). The idea of sustainability and digital economy in this cluster underscores the need for the development of digital villages by considering economic and social sustainability factors, and the use of remote sensing technology to monitor land and agricultural conditions in rural areas is an important component in optimizing agricultural products (Yang & Shahbaz, 2024).

The second cluster, represented by green, emphasizes aspects related to digital infrastructure and digital inclusion. In this cluster, topics such as digital inclusion, India, the sustainable development goals (SDGs), Internet of Things (IoT), and big data are particularly prominent. This cluster underscores the importance of access to digital technology for rural communities. The integration of technologies such as the Internet of Things (IoT) and big data will catalyze village transformation by empowering real-time data monitoring and analysis, thereby improving decision-making and resource management. The emphasis on the SDGs underscores the potential of technology to facilitate the realization of sustainable development goals, including poverty reduction, improved health, and increased educational opportunities.

The third cluster, which is colored red, discusses the topic of smart cities and digital transformation at the urban level, as well as the application of artificial intelligence (AI) in rural and urban development. In this cluster, terms such as "smart city", "artificial intelligence", "digital transformation", and "internet of things" become very important, Digital transformation signifies the process by which digital technology can change the way villagers live and work, while artificial intelligence will introduce advanced automation and analytics solutions for more efficient village management. Internet of Things (IoT) applications in villages can include natural resource management, smart agriculture, and improving the quality of life of village communities through technology-based solutions, so that although this cluster is more focused on cities, many of the concepts contained in it can be adopted to support the development of more advanced digital villages.

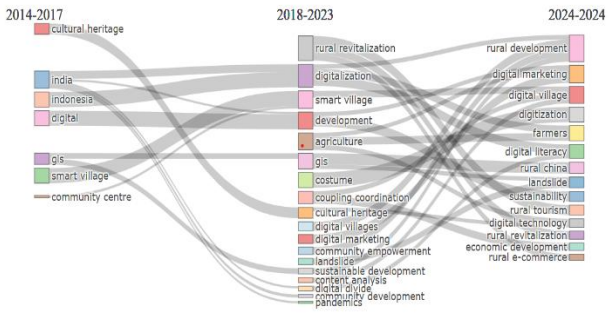

Figure 6. Evolution of the topic of smart cities in Developing Countries

The map of the evolution of this topic illustrates a significant change in the focus of research related to the development of digital villages between 2014 and 2024 From this map, it can be seen that during the period 2014-2017, the existing topics were more centered on cultural heritage and the use of GIS (geographic information systems), in addition to the concept of community centers. This indicates the importance of technology-based infrastructure development in supporting cultural preservation and community empowerment (Adami & Sigmaringo, 2023). However, between 2018 and 2023, there has been a shift towards the themes of smart villages, digitalization, and rural revitalization, which reflects an increased focus on the application of digital technologies to address development challenges in rural areas, as well as digital transformation as a solution to improve the quality of life and economic performance in the region (Komorowski, 2024).

This evolution shows that, while cultural heritage remains important, there is a visible

transition towards a concept that prioritizes the development of digital villages During the period 2018-2023, subjects such as smart villages, digital villages, and digital marketing are gaining increasing attention, signaling that digital technologies, which include digital marketing and e-commerce, are increasingly considered an important element in village development (Komorowski, 2024). At the same time, the concept of sustainable development and community empowerment is beginning to emerge as an integral component of efforts to build villages that prioritize not only technological advancement but also social and economic sustainability, this is further evidenced by the increasing discourse on agriculture and farmers, which underscores the important role of technology adoption in increasing productivity and sustainability of agriculture in the rural sector (S. Zhao et al., 2024).

In the 2024-2024 period, there will be a clearer transition towards the development of digital literacy, digital divide, and village e-commerce, which shows that the focus of digital village development is increasingly shifting towards meeting the needs of village communities to access and utilize technology effectively. Digital marketing and digital villages have also emerged as an important component in improving the village economy through online product marketing, as well as the use of e-commerce to facilitate the relationship between farmers and local products and the wider market (Hardaker, 2021). The findings show that the adoption of digital platforms in the agriculture and tourism sectors can drive revenue growth and accelerate economic development in rural areas that have historically experienced technological and infrastructure lagging. Finally, more advanced topics such as rural e-commerce and rural development emphasize the importance of integrating digital technologies in building more modern and sustainable villages (Yu & Wang, 2022).

Digital Villages Developed in Developing Countries

This study shows that the development of digital villages in developing countries, despite facing major challenges related to infrastructure and the digital divide, shows significant potential to improve the quality of life of rural communities. The application of digital technology in various sectors such as agriculture, education, and health can reduce the gap between villages and cities (S. Zhao et al., 2024). Although there are still challenges such as low digital literacy and limited access to technology, the results of the study show that government and private programs are starting to produce positive results. Adopting digital technologies has been shown to increase productivity, facilitate market access, and improve the quality of basic services in villages that have adopted them. The findings of this study show that despite the obstacles faced, digital technology has the potential to drive significant socio-economic change in these villages (Li, 2024).

The results of this study are consistent with the findings of previous research that digitalization can be a very effective tool to accelerate rural development in developing countries. (Bi, 2024). However, in contrast to the findings of some studies that exclusively emphasize technical and infrastructure aspects, this study includes a broader social dimension, including literacy (Setiansah et al., 2024). The research contributes to existing knowledge by offering a more nuanced understanding of the relationship between technology and socio-economic poverty. The findings of this study show that digitalization not only increases efficiency, but also encourages social integration and empowerment of village communities in the development process.(Patowary & Bhattacharjee, 2020). This research provides a new perspective on the country's ability to address social disparities and the capacity of rural communities to adapt to climate change.

The study has some limitations that must be acknowledged. Notably, the geographical scope, which is limited to a few developing countries, may not fully capture the diversity of global conditions. In addition, constraints on data availability and access to remote villages hinder the acquisition of comprehensive insights into technology implementation in conditions of limited resources (Shah, 2024). In addition, although the focus of this study is on the impact of digitalization, its analysis is limited by external factors such as government policies and socio-political dynamics, which cannot be fully controlled within the framework of this study. These limitations can affect the effectiveness of technology application and reduce the ability to generalize findings to a broader context, so further research is needed that can address the variation in village conditions at the global level (Tognisse et al., 2021).

Casually, we can think that despite the many obstacles, technology has the potential to tear down many walls so far that the village opportunity has been offered. Bringing better access to global markets or connecting farmers with more efficient tools alone can be a huge first step towards progress (Ngwenya et al., 2023). Just imagine, if more villages

can easily access information related to market prices or weather, then they can be better prepared to face challenges and achieve greater potential. All of this depends on how we support these changes with the right policies (Nidumolu et al., 2020). Thus, although technology may seem like a challenge at first, it is the key to optimizing the potential of villages that have been marginalized from the development of the digital world.

To address the reviewer's comment and align with the research goals, successful case studies from developing countries illustrate the key elements for developing digital villages. In Nepal, the Nepal Wireless Networking Project (NWNP) connected over 140 remote mountain villages to the internet, enabling access to e-commerce, education, telemedicine, and agricultural services (Karn et al., 2017). This initiative highlights the importance of community-driven efforts, appropriate technology, and international collaboration in overcoming rural infrastructure challenges, emphasizing the need for localized solutions and capacity building for sustainability and scalability (Sein et al., 2012). Similarly, BOSCO-Uganda established 55 community ICT centers in rural areas, leveraging solar-powered technology and local partnerships to improve education, healthcare, and economic development (Kato et al., 2020). This case underscores the significance of appropriate technology and local ownership in fostering digital inclusion, with NGOs and international organizations playing a crucial role. In Sri Lanka, the Fusion ICT4D movement, initiated by the Sarvodaya Shramadana Movement, has provided over 15,000 villages with access to Village Information Centers (VICs) that offer critical resources on agriculture, education, and governance, highlighting the importance of community participation, capacity building, and collaboration with government and academic institutions for successful digital solutions (Della Spina & Viglianisi, 2021). These cases demonstrate that successful digital village initiatives require a combination of appropriate technology, community involvement, capacity building, and collaboration among governments, NGOs, the private sector, and academic institutions. Overcoming challenges such as infrastructure deficits, digital literacy, and socio-economic disparities is essential for the sustainability of digital villages, and by learning from these examples, other developing countries can adopt and adapt strategies to bridge the digital divide and promote inclusive development.

The Results and Discussion section already provides an in-depth analysis of publication trends and international collaboration. However, the article could be stronger by linking the findings to policy implications. The discussion focuses more on academic mapping, while more practical guidance for stakeholders such as the government, the private sector, and NGOs is lacking. Linking the research results to related policies, such as digital infrastructure development and digital literacy improvement, would contribute more to supporting digital village development policies in developing countries.

CONCLUSION

This study addressed two key research questions: (1) What are the main challenges and opportunities in developing smart villages in developing countries? and (2) How can ICT and other technological innovations be implemented in rural areas to improve people's lives and economic conditions? The research shows that substantial opportunities exist while developing digital villages in these regions face significant challenges, such as inadequate digital infrastructure, low digital literacy, and limited technological access. The adoption of ICT in agriculture, education, and healthcare sectors has proven to bridge the rural-urban divide by improving productivity, market access, and basic services. Furthermore, successful initiatives, such as China's Digital Village programs, demonstrate that digital technology can facilitate socio-economic transformation and empowerment in rural areas with proper government policies, community participation, and targeted digital literacy programs.

This research contributes to the knowledge on innovative village development by integrating technical and infrastructure aspects and the broader social, cultural, and economic factors that influence the acceptance and success of digital technologies in rural communities. Focusing on socio-economic dimensions, this study offers a more nuanced understanding of how digitalization can drive sustainable rural development. Additionally, the research proposes an inclusive, innovative village model that emphasizes both technological infrastructure and the empowerment of communities through digital literacy and active participation in the development process. This perspective adds a new dimension to existing literature by addressing the technological and human factors crucial for the success of digital villages.

Despite the valuable insights, this study acknowledges several limitations. The geographical

scope, which focuses on a few developing countries, may not fully capture the diversity of global conditions. Constraints on data availability and access to remote villages also hinder the acquisition of comprehensive insights into technology implementation in resource-limited settings. Moreover, the analysis was limited by external factors such as government policies and socio-political dynamics, which are difficult to control within the scope of this study. Future research should explore these external factors in more detail, using qualitative and quantitative methods to understand how these variables affect the implementation of digital village models. Additionally, more case studies from different regions are recommended to develop a more comprehensive framework for replicating successful digital village models globally.

Despite the valuable insights provided through this research on rural digitization in developing countries using a literature review with the Scopus database, there are still some shortcomings. Therefore, it is recommended that future research be conducted in the form of exploratory studies on qualitative and quantitative methods to fill the gaps in this research.

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