

# Technology Integration and Community Empowerment in Smart Villages: Bibliometric Analysis

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**Abstract:** This research explores the concept of Smart Villages, focusing on the challenges and opportunities in their implementation in rural areas. The study emphasizes social sustainability, community empowerment, and the role of technology in improving quality of life. The objectives are twofold: to understand the role of international collaboration in accelerating smart village development and to explore the implications of these findings for future development. Bibliometric analysis is used to map research progress and identify strategies for integrating technology into smart village management. The findings offer practical implications for public policy design, showing the potential for creating more inclusive and sustainable strategies for smart village implementation. The study highlights the importance of cross-sector collaboration and empowering village communities in policy planning and execution. It also provides insights into addressing challenges related to technology application in rural areas, as well as improving social and environmental sustainability through technology-driven solutions. This research contributes by combining technical, social, and cultural analysis in the development of smart villages. Its value lies in a holistic approach, considering social, cultural, and economic diversity when designing solutions. Additionally, it fills gaps in existing literature by incorporating international perspectives, with a special focus on developing countries.

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## INTRODUCTION

The Smart Village concept integrates information and communication technology (ICT) with various infrastructure and social elements in rural areas. The goal of this combination is to improve the quality of life, encourage sustainability, and improve public services (Khan et al. 2023). The concept under discussion involves the application of technology to improve sectors such as education, health, agriculture, energy, and transportation in rural areas (Verma et al. 2024). Therefore, Smart Village aspires to realize a more efficient, inclusive, and sustainable village by utilizing technological innovations to answer the challenges faced by rural communities (Bhosale, Patil, and Sankhe 2023). In this context, the importance of collaboration between governments, the private sector, and local communities is crucial for the successful implementation of Smart Villages, as reflected in international collaboration networks involving countries such as China, India, and Indonesia (Navarro and Cejudo 2020).

Although the concept of Smart Villages has come a long way, there are still significant gaps in the literature regarding the practical and social challenges faced during its implementation (Dembogurski et al. 2025). The majority of research focuses on technical and infrastructure aspects; However, they do not address the socio-economic and cultural limitations that exist in rural areas (Lahrech et al. 2024). In addition, most studies have been conducted in developed countries or urban areas, with minimal attention to rural contexts, especially in developing countries. These differences pose challenges in adapting technologies that have proven to be successful in one region to be applied effectively in another, which may have different social and economic conditions (Li, Chen, and Wu 2020). The existing literature often overlooks the importance of the active involvement of rural communities in the process of planning and implementing technology.

To address existing inequalities, this study proposes a more holistic solution with a focus on social sustainability and community involvement in every stage of Smart Village implementation (Zavratnik et al. 2020). By analysing the various initiatives that have been implemented, the aim is to identify best practices that can be adapted to meet diverse local needs (McNamara et al. 2020). International cooperation, as reflected in the map of cooperation between countries, can also be a model for creating synergies between various stakeholders. An important example of this is the cooperation between China and Indonesia in the development of smart villages (Susilowati, Rachmawati, and Rijanta 2024). In addition, the application of technology for natural resource management and environmental monitoring, a strategy that has proven to be highly effective in various case studies, can be used to address sustainability and conservation issues in rural areas (Rai et al. 2024).

The main motivation of this research is to explore the effective application of technology in the development of Smart Villages in different countries. The focus of this exploration is on rural community empowerment and social diversity management (Emerllahu and Bogataj 2024). As a researcher motivated by the transformative impact of technology in improving the quality of life in rural areas, I was compelled to delve deeper into the intricate interplay between various factors, including technology, policy, and local culture, in driving positive change in rural communities (Gómez-Carmona et al. 2023). The experience of observing the significant potential of technology in rural community empowerment is a key driver to expand understanding of the implementation of a more inclusive and sustainable Smart Village (Subanda and Dewi 2024).

The main objective of this study is to explore and analyze several factors that affect the successful implementation of Smart Villages (Ayodyani, Nazeer, and De Alwis 2023). The focus of this analysis is on cross-sector collaboration and community empowerment. The aim of this study is to provide a more precise picture of the challenges faced in technology integration in rural areas, and to identify solutions that can be implemented to create smarter and more sustainable villages (Yu et al. 2024). It is hoped that the findings of this study will provide policy suggestions that can assist stakeholders in

designing more effective strategies for the development of Smart Villages in various regions.

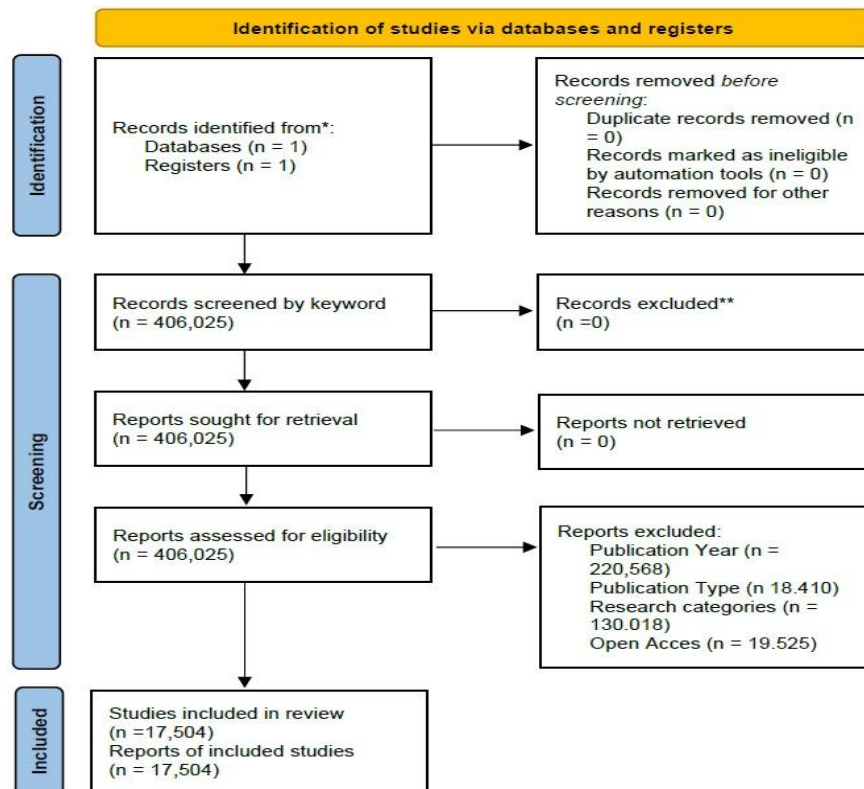
This research offers a more comprehensive approach to Smart Village studies, by combining technical, social and cultural analyses within a holistic framework. A significant innovation of this research is the use of a case study-based approach, which involves collaboration between different countries and has not been widely explored in the relevant literature (Lakshmanan et al. 2022). In addition, this research underscores the importance of the active involvement of village communities in every stage of planning and implementation, as well as the integration of technology with social and environmental sustainability as determinants of long-term success (Sulaiman 2024). A further innovation is the contribution of this research to the development of evidence-based policies, which have the potential to accelerate the implementation of Smart Villages in developing countries, which often face different challenges that developed countries do not experience (Utamajaya et al. 2023).

## **RESEARCH METHOD**

The PRISMA diagram shown in this image illustrates the systematic and transparent process of selecting studies for a systematic review or meta-analysis of the Smart Village concept (Page et al. 2022). This process begins with the identification stage, where a large number of records ( $n = 406,025$ ) are obtained from databases and registers. At this stage, no records are deleted prior to screening, indicating that all records found are considered for further examination without automatic selection or deletion based on specific criteria (Rastkar 2025).

Furthermore, at the examination stage, the identified records were screened using relevant keywords, resulting in 406,025 reports that were then further checked to qualify (Park et al. 2024). At this stage, no reports were excluded from the initial analysis, illustrating that all reports met the basic criteria to be considered in this study (Junaidi et al. 2025). This demonstrates a commitment to a careful and systematic selection process, which aims to identify studies that are highly relevant to the topic of Smart Villages (Alhari, Febriyani, and Fajrillah 2022).

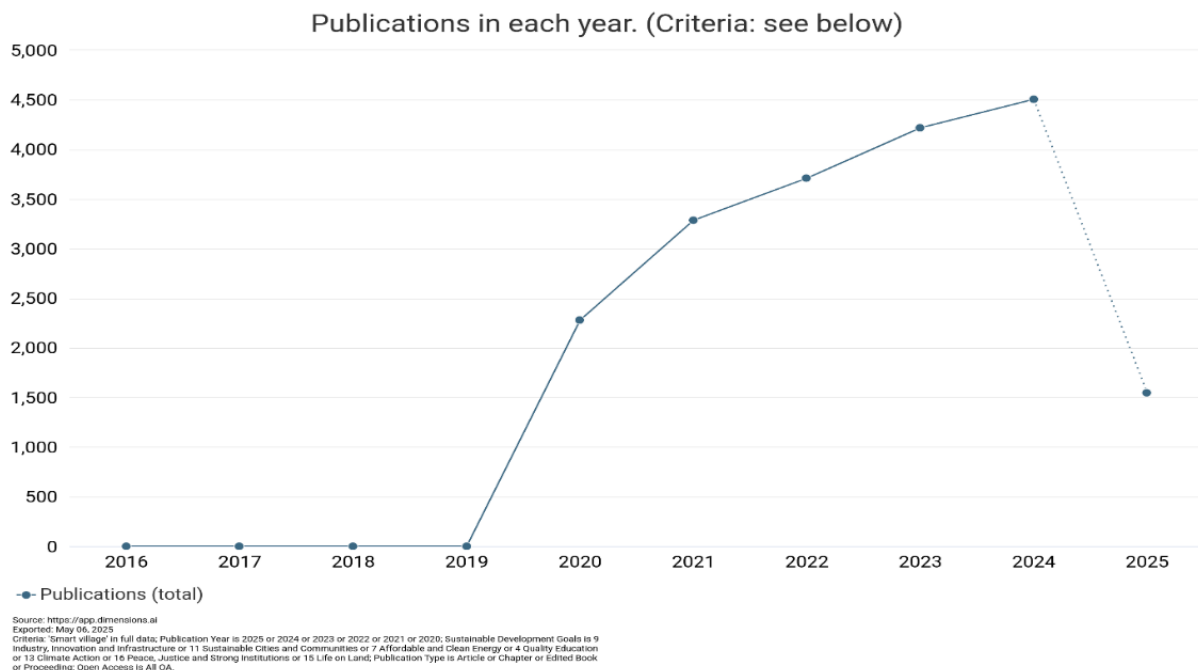
The final stage of the review, the inclusion stage, revealed that of all the reports considered, 17,504 studies met the inclusion criteria and were included in the systematic review (Nundy, Kakar, and Bhutta 2022). And also the exclusion of the report is not affected by factors such as the year of publication, the type of publication, the category of the research, or the status of open access. This shows that the selection was made solely based on the quality and relevance of the research, without bias towards these factors (Molléri, Petersen, and Mendes 2018). This process reflects a rigorous and objective approach in selecting the most appropriate research to discuss the concept and implementation of Smart Villages (Singh et al. 2022).



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

**Source:** Author created through prism modelling, 2025

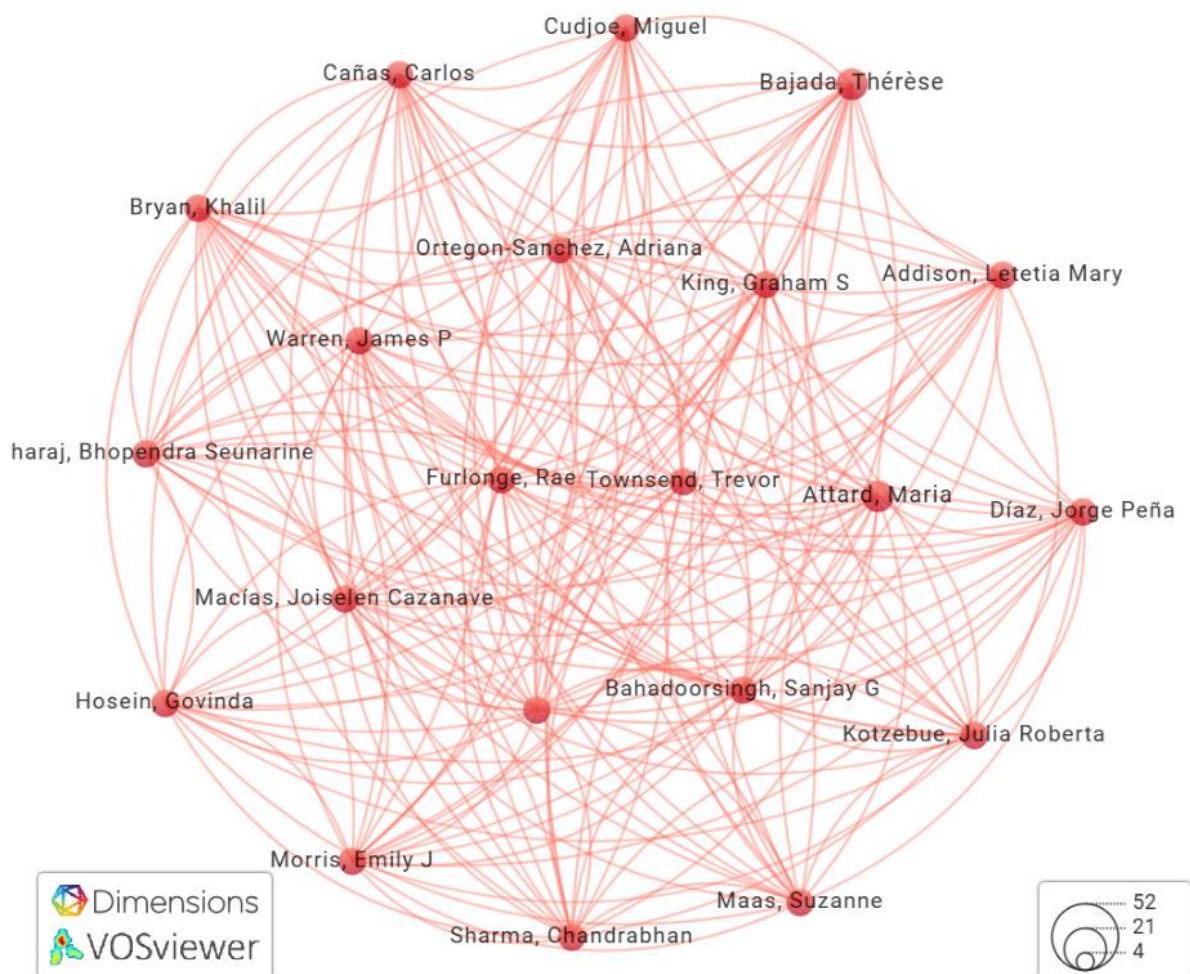
## RESULTS AND DISCUSSION



**Figure 2.** Trend in the number of publications  
**Source:** Data processing from the Scopus database

Figure 2 shows a graph of the publications produced each year, with a focus on the concept of Smart Villages. Data analysis shows a substantial growth in the number of publications, especially from 2019 to 2022. From 2016 to 2018, the number of publications was insignificant. However, in 2019, there was a significant increase, followed by continued growth until 2022, with the number of publications reaching more than 3,000 publications. However, after 2022, the chart shows a sharp decline in 2023 and is predicted to continue into 2025, with very few publications in 2025.

These findings suggest a period of increased focus on the concept of smart villages between 2019 and 2022, which may be due to increased encouragement to develop technologies and infrastructure that support the Sustainable Development Goals (SDGs) (Maja, Meyer, and Von Solms 2020). However, in the following years, there was a marked decline, which may have been caused by a variety of factors, including a decline in interest in publications among the scientific community or a shift in research priorities. The graph further illustrates that this publication relates to the industrial sector which includes innovation, sustainable infrastructure, clean energy, education, and social justice, which is in line with SDGs goal number 9 regarding infrastructure and technology development.



**Figure 3.** Network visualization  
**Source:** Data processing from the VOSviewer

Figure 3 shows a network map that illustrates the relationships between various individuals involved in scientific publications or collaborations related to the topic of Smart Villages. Each point on the image represents an author or researcher, while the lines connecting them indicate a collaborative relationship or reference between those individuals in a related publication. It has been shown that a person's level of involvement in publications and collaborations is directly related to the size of their dots. For example, the presence of a larger dot signifies an author who has many connections or involvement in various publications about Smart Villages.

The network features a number of high-level collaborations between a number of researchers in this field, with certain individuals occupying a more prominent position in the middle of the map. This shows that these individuals play an important role in developing research and innovations related to smart villages (Ghimire, Khatri-Chhetri, and Chhetri 2022). The network provides a comprehensive overview of how researchers are connected and collaborating to build knowledge around the concept of Smart Villages. This concept includes the use of technology and innovation to improve the quality of life and infrastructure in rural communities. This emphasizes the importance of collaboration in achieving the goal of successful Smart Village development.

**Table 1.** Trends on the topic of Technology Integration and Smart Village Community Empowerment

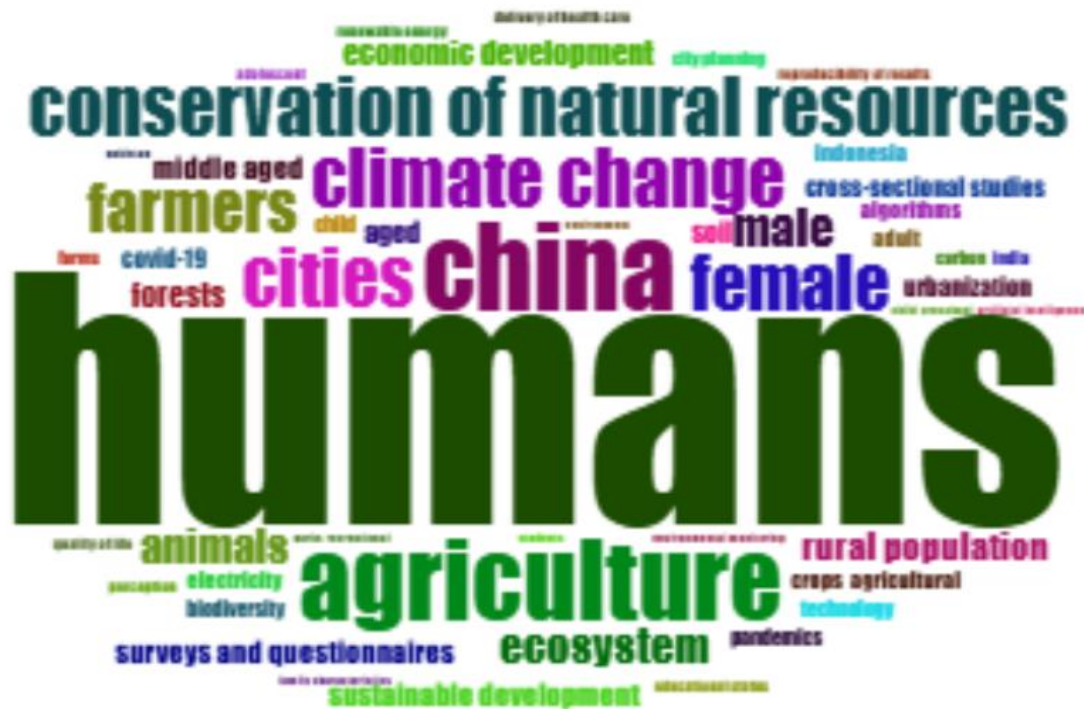
Term	Frequency	Year (Q1)	Year (Median)	Year (Q3)
<b>Humans</b>	129	2022	2023	2024
<b>China</b>	44	2022	2023	2024
<b>Agriculture</b>	42	2022	2023	2024
<b>female</b>	28	2022	2024	2024
<b>Male</b>	20	2024	2024	2024
<b>Animals</b>	18	2022	2022	2024
<b>Economic Development</b>	13	2022	2022	2024
<b>Forests</b>	13	2022	2024	2024
<b>Electricity</b>	9	2022	2022	2022

**Source:** data taken by the author through the R-Studio application, 2025

Table 1 shows the frequency of use of terms related to the concept of Smart Villages in publications over several years. The term 'human' was recorded as appearing the most often, with 129 occurrences, reflecting its primary focus on human well-being and the application of technology to improve the quality of life. Furthermore, the terms 'China' and 'agriculture' appear with frequencies of 44 and 42 times, respectively. These findings show the importance of China's role in technological innovation and technology application in the agricultural sector, which is an integral part of smart village development. The terms "women" and "men" show that gender issues are also part of the discourse in Desa Pintar's research, with the term "women" more prominent in 2024.

Meanwhile, terms such as "animals", "economic development", and "forest" show a correlation with environmental sustainability and economic development, which is recognized as the pillar of Smart Village development. Animals serve to demonstrate the importance of biodiversity in the conceptualization of smart villages, while economic development shows an emphasis on improving the economy through the application of technology (Doley and Barman 2023). Although not very prevalent, electricity remains

an integral component of the Smart Village concept, emphasizing the importance of basic infrastructure. The data presented here provides a comprehensive overview of the various dimensions that must be fully considered during the design and development of technology-based, environmentally friendly, and inclusive smart villages.



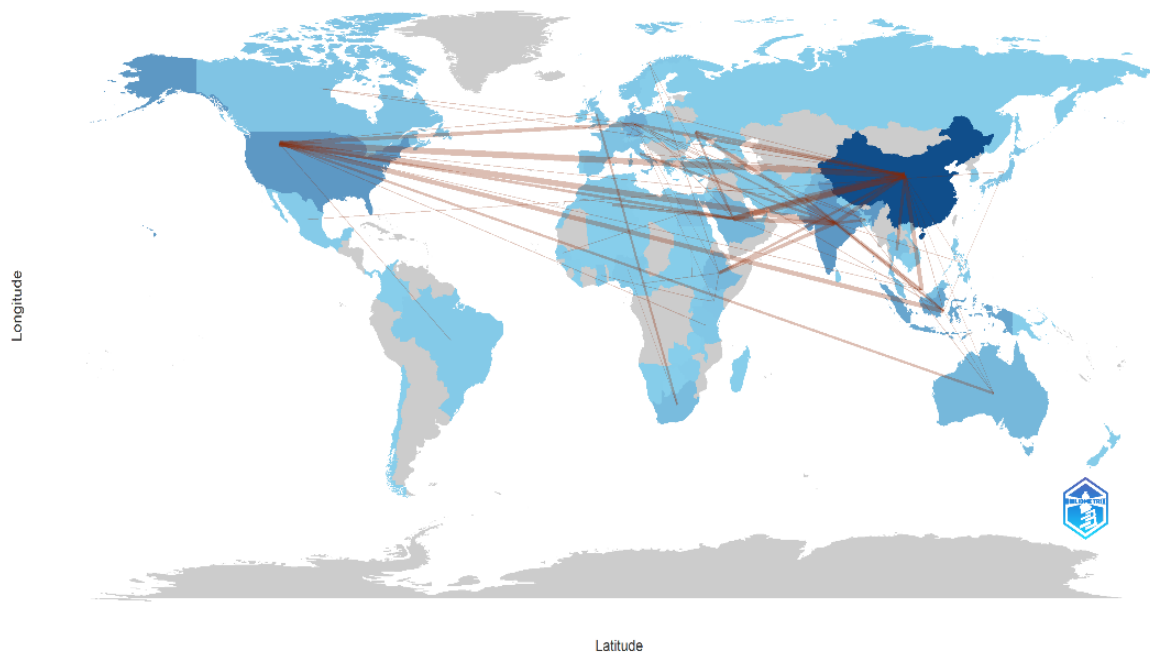
**Figure 4.** The topic of the emergence of Technology Integration and Smart Village Development.

**Source:** Utilization of RStudio in the context of data processing.

Figure 4 shows a visual representation in the form of a word cloud that shows the frequency of use of terms related to the concept of Smart Village. The term 'human' is the most widely used, indicating that this research places a significant emphasis on human well-being, quality of life, and the application of technologies that have a direct impact on society. It is clear that a number of other terms, including 'China', 'agriculture', 'economic development', and 'climate change', are also frequently found. These terms reflect subjects related to sustainability, technology-based economic development, and the impact of climate change, as they relate to the development of smart villages.

In addition, the terms 'cities', 'villagers', and 'urbanisation' state that the development of Smart Villages also involves comparisons between villages and cities, as well as an exploration of how technology can address the problem of population shifts from villages to cities. Ethical treatment of animals, ecosystem conservation, and conservation of natural resources are integral components of the eco-friendly principles underlying Smart Village (Mukti et al. 2022). This image provides an overview of the key focus of Smart Village research: human well-being, sustainability, and the development of technologies that have the potential to improve rural life.

## Country Collaboration Map

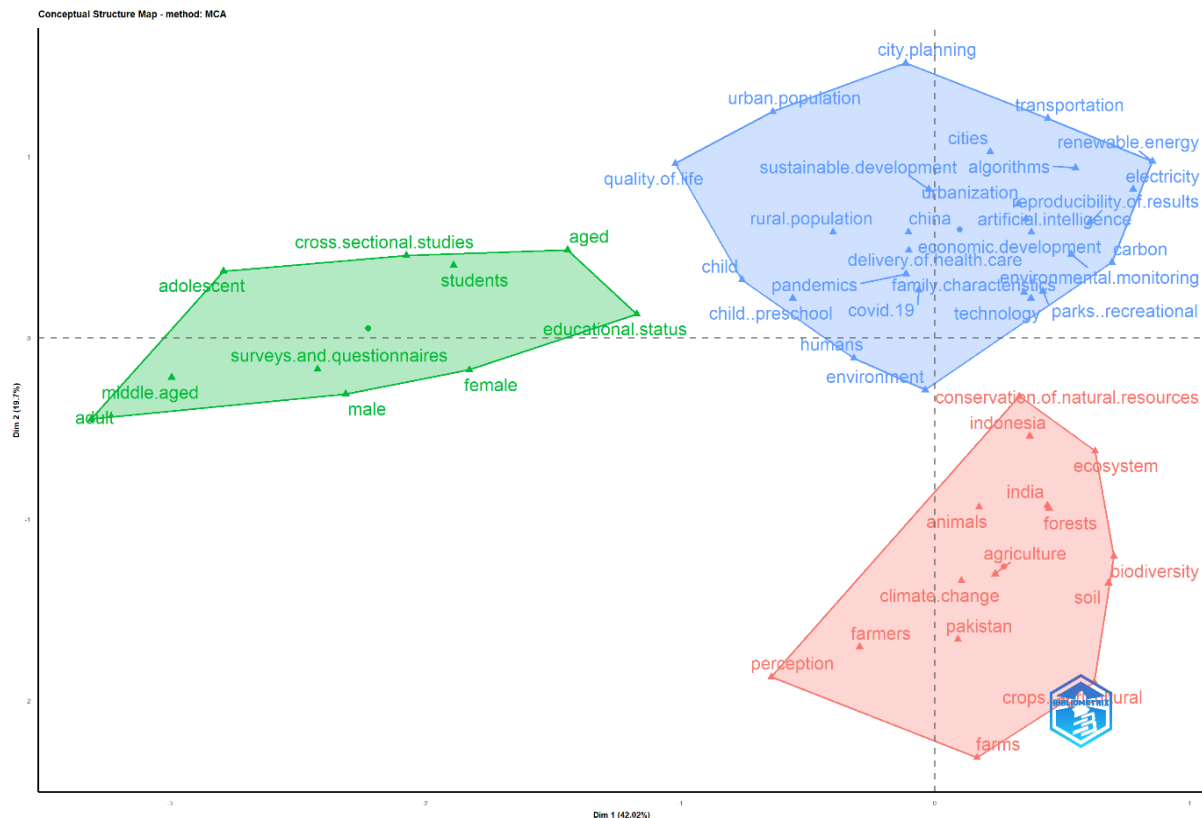


**Figure 5.** Collaboration Map

**Source:** Utilization of RStudio in the context of data processing.

Figure 5 shows a map of cross-border collaboration, which illustrates the relationships between different countries involved in research or development related to the topic of Smart Villages. In this map, countries that show close cooperation, especially with China, are distinguished by darker colors and thicker lines, which indicate substantial information exchange or collaborative research efforts. The lines connecting these countries indicate the existence of an international collaboration network that supports innovation in the application of technology for the development of smart villages.

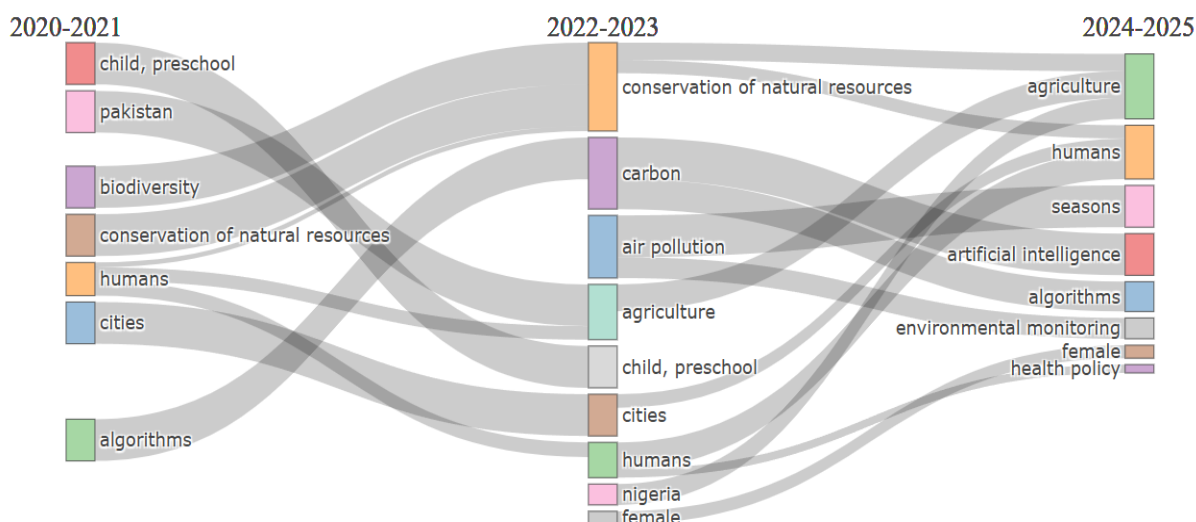
This map shows that cooperation in the development of Smart Villages is not limited to one region, but covers many countries around the world. It is evident that countries adjacent to China, such as India and other Asian countries, show a higher level of collaboration in the field of research and development (Mukti et al. 2022). This underscores the importance of international collaboration in the development of technology-based solutions to address the challenges faced by rural communities, including the provision of infrastructure, clean energy, and natural resource management. This cartographic depiction illustrates the need for transnational collaboration to achieve optimal results in the implementation of the Smart Village concept on a global scale.



**Figure 6.** Conceptual Structure Map  
**Source:** Data processing using RStudio.

Figure 6 shows concept map that illustrates the relationship between various terms relevant to the topic of Smart Village, using the Multiple Correspondence Analysis (MCA) method. The map is designed in such a way as to divide the terms related to Smart Villages into three main groups based on their proximity in certain dimensions. The first group, shown in green, focused on social and demographic aspects, which included adolescent, middle-aged, learner, and the use of surveys and questionnaires. These elements study the characteristics of the village population and the methodologies used in data collection during the research. The group focuses on the importance of social understanding in the context of smart village development, especially as it relates to issues of education and social status.

The second group, which is blue, consists of concepts that are more closely related to infrastructure and sustainable development, including quality of life, sustainable development, urban population, and economic development. These findings emphasize the importance of topics related to improving the quality of life through infrastructure, renewable energy, and urban planning in the context of Smart Villages. In contrast, the third group, which is red, focuses on environmental and natural resource issues, including climate change, animals, agriculture, and ecosystems (Taji, Saraf, and Regulwar 2021). This group serves to illustrate the importance of nature conservation, sustainable agriculture, and natural resource conservation in designing an environmentally friendly smart village. This map provides a comprehensive overview of various dimensions that need to be considered in the development of Smart Villages, including social aspects, economic development, and environmental sustainability.



**Figure 7.** Evolution of the topic of Technology Integration and Smart Village Development

**Source:** Data processing using RStudio

Figure 7 shows a Sankey diagram that illustrates the shifts and relationships between various terms related to the topic of Smart Villages from the period 2020-2021 to 2024-2025. The following diagram illustrates the evolution of the subject's focal point over time. In the 2020-2021 period, the following terms were seen to be very dominant: 'children', 'preschool', 'Pakistan', 'biodiversity', and 'natural resource conservation'. The terms describe a focus on early childhood education and significant environmental issues. These terms also reflect the importance of social and nature conservation aspects in the development of Smart Villages.

Entering the 2022-2023 period, there has been a shift in focus towards carbon issues, air pollution, agriculture, and environmental monitoring. This signals a growing recognition of the global environmental challenges posed by climate change and the need for comprehensive pollution monitoring. In addition, the agricultural sector is increasingly prominent in the development of smart villages, which underscores its role in sustainable development. In the period 2024-2025, further changes are anticipated, with the emergence of topics such as agriculture, artificial intelligence, health policy, and seasons. These developments show that technological advances and health policies are increasingly influencing the design and implementation of Smart Village initiatives (Praveen et al. 2023). The diagram below illustrates the evolution of research priorities in the field of smart village development, showing the shift in focus from one balance to another between technology, the environment, and social aspects over time.

### ***Insights on Technology Integration and Smart Village Development***

Statistical data analysis has shown the importance of international cooperation in the context of Smart Village development, as evidenced by the collaborative relationships depicted in the international cooperation map (Tosida et al. 2022). It is clear that countries such as China and India are taking a leading role in the field of innovation and research related to smart villages. These countries have established networks that facilitate interaction among various stakeholders, including government entities, private

sector organizations, and communities (Chen and Song 2025). In addition, the use of sustainable and environmentally friendly technologies, such as real-time environmental monitoring and technology-based agriculture, is also considered highly relevant in the creation of sustainable solutions for villages. While there is considerable potential in the application of technology in rural areas, challenges such as the digital divide and limited infrastructure in remote areas must be addressed (Naik, Narasinga Rao, and Baje 2020).

In addition, findings from term frequency data and concept maps show a strong link between the topic of Smart Villages and sustainability, quality of life, and natural resource management. The terms "human", "agriculture", "economic development", and "environmental monitoring" reflect various aspects that must be considered in planning a Smart Village, both from a social, economic, and environmental perspective. The successful implementation of Smart Villages depends not only on technological factors, but also on the adaptation of the technology to the local context, a process that involves the active participation of the village community (Gorain 2022). This research emphasizes the need for technology-based solutions tailored to the specific needs of each region, as well as the importance of policy support that encourages the development of smart villages in an inclusive and sustainable manner (Valliappa and Sampath Kumar 2022).

The development of Smart Villages is hampered by a number of significant challenges, which can be categorized into three areas: technology, infrastructure, and socio-economy. A significant challenge is the digital divide that still exists between rural and urban areas, which hinders the adoption of advanced technologies in rural communities (Darmawan et al. 2023). In addition, the scarcity of human resources with the necessary expertise in high technology, coupled with the challenges associated with the development of appropriate infrastructure in remote areas, is a significant obstacle. In addition, another challenge is the management of the diverse needs of rural communities, where the application of technology must be able to adapt to the local context without ignoring the social, cultural, and economic aspects that characterize the village (Jakobsen, Mikalsen, and Lilleng 2023). Financing constraints and regulatory tools that have not yet fully supported it also hinder the acceleration of the implementation of the Smart Village (Renukappa et al. 2024).

The findings of this study show that Smart Villages have the potential to be a solution to improve the quality of life in rural areas through the integration of technology to improve basic infrastructure, education, and access to health. The findings of this study show that the development of smart villages should not only be focused on technical aspects, but should also consider environmental sustainability and active community participation (Fazira, Sudarmo, and Yuliani 2024). Governments, the private sector, and local communities must collaborate to address the challenges they face and ensure more effective implementation. In addition, the implementation of artificial intelligence (AI)-based solutions and real-time environmental monitoring has improved efficiency and sustainability in certain domains, although their application is still limited to certain regions (Syafudin, Fitriyani, and Anshari 2025).

There are two limitations of this research. First, the scope of this study is limited to case studies in specific regions, which may not be able to fully describe the complexity and diversity of challenges that exist around the world. This research is also limited in terms of access to broader data on the direct impact of Smart Village implementation on economic and social development in rural areas. Nevertheless, the contribution of this research to policy and science is quite significant, especially in providing insight into how public policies and private sector support can be more effective in encouraging inclusive and sustainable smart village development (Muhtar et al. 2023). In the field of study, this research contributes to the existing literature on the application of technology in the context of villages and enriches the understanding of the role of collaboration between parties in creating holistic solutions (Chu, Lam, and Williams 2023).

## **CONCLUSION**

This study provides significant insights into the development of Smart Villages, with a particular focus on the use of technology to improve the quality of life in rural areas. The findings also show that while technology has the potential to have a positive impact in the areas of resource management, basic service provision, and economic improvement, there are still significant challenges. These challenges include the digital divide, limited infrastructure, and socio-economic disparities between rural and urban areas. The implementation of Smart Villages requires interdisciplinary collaboration between governments, the private sector, and local communities to ensure acceptance and adaptation of proposed technological solutions to the local context.

This research will take a case study approach, examining various Smart Village initiatives that have been implemented in several regions, with the aim of assessing their impact on social and economic development in rural areas. The steps taken include the collection of primary data through interviews with local stakeholders, as well as the collection of secondary data related to policies and the results of technology implementation in smart villages. This analysis will include an evaluation of the successes and challenges faced during the application of technology in rural settings, with the aim of providing more targeted and evidence-based advice.

This research is very important because it can provide a deeper understanding of how technology can be effectively integrated in the development of sustainable and inclusive smart villages. The impact of this research on this field of study is quite large, because it can contribute to the formulation of more effective policies to support the development of Smart Villages. The results of this research are expected to enrich the existing literature on technological innovation in rural areas, as well as provide insights for policymakers and practitioners in designing solutions to address rural challenges, improve quality of life, and promote socio-economic sustainability in rural areas.

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