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Comparative Discourse of Smart City and Smart Village in Asia, Case of Indonesia, Malaysia, and Japan

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ABSTRAK

Wilayah perkotaan dan pedesaan di seluruh dunia semakin menghadapi tantangan pertumbuhan penduduk pesat, perubahan iklim, serta keterbatasan sumber daya. Untuk mengatasinya, pemerintah mengadopsi konsep kota pintar dan desa pintar berbasis teknologi guna mendukung pembangunan berkelanjutan. Namun, diskusi akademis mengenai topik ini sangat bervariasi antarnegara, dipengaruhi oleh prioritas kebijakan, isu pembangunan, dan latar belakang riset masing-masing. Studi ini melakukan analisis bibliometrik komparatif terhadap penelitian kota pintar dan desa pintar di Indonesia, Malaysia, dan Jepang, berdasarkan publikasi terindeks Scopus yang diolah menggunakan VOSviewer. Hasilnya menunjukkan bahwa Indonesia berhasil mengintegrasikan kedua bidang secara signifikan, dengan pergeseran fokus dari teknologi menuju tata kelola kolaboratif dan keberlanjutan. Sebaliknya, Jepang menerapkan pendekatan sistematis dan infrastruktur-sentris pada kota pintar, tetapi penelitian desa pintarnya kurang terkait dengan isu pedesaan seperti depopulasi dan penuaan penduduk. Di Malaysia, penelitian desa pintar justru lebih banyak tertuju pada bidang biomedis dan kesehatan masyarakat ketimbang pengembangan pedesaan berbasis teknologi, mengindikasikan kesenjangan riset yang mencolok. Temuan ini dapat membimbing pembuat kebijakan dalam menentukan prioritas riset, membantu alokasi dana ke bidang yang kurang dieksplorasi, serta merancang kerangka pengukuran yang seimbang antara standar global dan kebutuhan lokal. Pada intinya, meski konsep pembangunan cerdas bersifat global, implementasi dan kajian akademisnya harus disesuaikan dengan konteks spesifik setiap negara.

ABSTRACT

Urban and rural areas worldwide face growing challenges from rapid population growth, climate change, and resource constraints. Governments are responding by adopting smart city and smart village initiatives that use technology to promote sustainable development. Yet, academic research on these topics differs markedly across countries due to distinct policy priorities, development needs, and research contexts. This study performs a comparative bibliometric analysis of smart city and smart village publications in Indonesia, Malaysia, and Japan, using Scopus-indexed data processed with VOSviewer. Results show Indonesia has effectively integrated both domains, with research evolving from a technology focus toward collaborative governance and sustainability. Japan, meanwhile, emphasizes systematic, infrastructure-driven smart city development, but its smart village studies remain disconnected from key rural issues like depopulation and aging populations. In Malaysia, smart village research predominantly centers on biomedical and public health themes rather than technology-based rural advancement, revealing a clear research gap. These findings can inform policymakers on research prioritization, guide funding toward underrepresented areas, and aid in creating balanced measurement frameworks that align global standards with local realities. Ultimately, although smart development concepts are global, their academic exploration and practical application must be adapted to each country's unique context.

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INTRODUCTION

Urban areas are crucial for development due to their accessibility, job opportunities, and resource availability, attracting many residents. This rapid urbanization, however, poses challenges related to population growth, resource demand, and infrastructure, especially in light of climate change. By 2020, around 60% of the global population was projected to live in urban areas, rising to 70% by 2050 (UNHCR, 2022). As urban populations grow, sustainable initiatives are necessary to address these demands (Khan et al., 2020).

As a city's population grows, the demand for resources, transportation to ensure mobilization, and infrastructure will also increase. Thus, to provide a sustainable quality of life for people, a city must be able to meet these needs. Urban areas must be able to consider scenarios and identify ways to manage these challenges with sustainable initiatives (Khan et al., 2020). In addition to the challenge of concentrating population growth in urban areas, based on a report from UNHCR (2022), there is a decrease in population in rural areas, from 22 percent to 18 percent. A new development concept is needed to deal with population growth that is only concentrated in urban areas, so that the rural population does not decline (Kristiningrum & Kusumo, 2021). In line with that, a country with a large area encompassing various cities, districts, and villages has different needs in each region, especially between urban and rural areas (Montalvo et al., 2019). Simultaneously, rural populations are declining, necessitating a development concept that balances growth between urban and rural areas (Kristiningrum & Kusumo, 2021). In response, the Indonesian government has launched smart city and smart village programs aimed at leveraging technology for effective public services (Aldoseri et al., 2024). And technological development is a key pillar in modernizing public services (Marthalina et al., 2025). In 2014, the “Digital Agenda for Europe” promoted a more effective use of Information and Communication Technology support for effective and efficient service delivery and improved quality of life (Radoglou Grammatikis et al., 2019).

The smart city concept harnesses Information and Communication Technology (ICT) to improve urban services and quality of life (Khan et al., 2020). While the definition of a smart city varies, it broadly serves as a tool for local governments to achieve sustainable development and improve governance (Myeong et al., 2020). Additionally, smart villages, though less highlighted, aim to enhance rural development by utilizing ICT to improve the quality of life and create local economic opportunities (Wu et al., 2018).

There are notable disparities in the implementation of smart city and smart village policies across regions, prompting research to compare their measurement indicators. This study focuses on Indonesia, Malaysia, and Japan, examining their smart programs and integrating measurement models for a comprehensive assessment of both urban and rural areas. Through a bibliometric approach, the research maps trends in academic publications on these indicators, identifying temporal trends, researcher collaborations, and dominant themes. The aim is to reveal research gaps and priorities in each country, ultimately enhancing the integration of smart city and smart village indicators.

Addressing gaps in prior research, this study answers three questions: (1) What are the leading research themes and their evolution in smart city and smart village publications from Indonesia, Malaysia, and Japan? (2) How do collaboration networks and keyword co-occurrence patterns vary among these countries, and what do they indicate about research priorities? (3) What knowledge gaps and research opportunities exist within each country's approach to smart urban and rural development? Examining these through bibliometric analysis provides insights for policymakers developing context-sensitive measurement frameworks and reveals both shared

patterns and unique national features in academic engagement with smart development.

This comparative analysis uses policy transfer and diffusion theory to explore how different countries adopt, adapt, and study global smart development ideas. Indonesia, Malaysia, and Japan were chosen as case studies because they represent varying paths of development and different stages of smart initiative progress in Asia. Indonesia is an emerging economy actively implementing both smart city and smart village programs to address rapid urban growth and ongoing rural challenges. Japan, as a developed country, has advanced urban infrastructure but faces significant rural depopulation and an aging population, creating interest in using smart technologies for rural revitalization. Malaysia, as a middle-income nation, is experiencing development transitions and working to address the gap between urban and rural areas.

These countries share ASEAN+3 cooperation frameworks facilitating policy learning (Jones & Hameiri, 2020), yet differ significantly in governance structures, technological capabilities, and demographic patterns. This variation enables identification of which aspects of smart development research reflect global consensus versus context-specific adaptations. Examining publication patterns reveals how academic communities engage with smart development concepts, which themes receive sustained attention, and where knowledge gaps might hinder effective policy implementation.

Literature Review

Global Smart City Concepts

Smart cities are challenging to define due to their multidimensional nature (Kozlowski & Suwar, 2021). When considering a definition for smart cities, it is essential to focus on the maturity of the smart city ecosystem, which encompasses governance, strategy, personnel, and skills. It is also important to recognize how various stakeholders perceive the opportunities, values, and benefits of smart cities (Singh Kapoor, 2017). The concept of smart cities has gained popularity over the past decade, allowing communities to better address their housing, transportation, energy, and other infrastructure needs. Additionally, smart cities serve as a crucial tool in combating poverty, reducing unemployment gaps, and managing energy resources (Winkowska et al., 2019). A smart city represents a modern urban environment where information and communication technology are employed to sense, analyze, and integrate critical information for city operations. This enables quick and effective responses to diverse demands, including residents' needs, environmental protection, public safety, city services, and industrial and commercial activities (Lai et al., 2020).

The Ministry of Communication and Information developed six dimensions for the development of smart cities in priority areas (Syah et al., 2024), smart governance contributed to decision-making, public services, social services, transparent government, and policies and strategies, where they mention government as a coordinator that can help achieve maximum benefits from smart cities in terms of reliability, efficiency, and effectiveness of community services by integrating public, private, and civil officials. Smart branding contributes to increasing regional competitiveness by structuring city structures and marketing regional potential at local, national, and international levels (Khaerani et al., 2025). A smart economy is a knowledge economy based on cutting-edge research across all disciplines, such as science, industry, business, cultural heritage, architecture, planning, and development (Vinod Kumar & Dahiya, 2017). Smart living includes smart buildings, education, and health (Sharif & Pokharel, 2022). In a smart society, the main goal of this dimension is the development of three elements, namely communities,

learning ecosystems, and security systems (Nambassa & Suswanta, 2025). Smart environment includes improved waste disposal, pollution control, energy management, smart grids, and residential area management, air and water quality, green space improvement, and emissions monitoring (ZAKKA et al., 2025).

Smart villages are a very broad concept, with utilizing the functions of society in the digital age to develop villages being one of the main pillars in creating smart villages (Masrich et al., 2023). Building a Smart Village can be an innovative solution to realize village independence so that it has stronger economic resilience both amid the current pandemic and in facing various dynamics of environmental change in the future. The “Smart Village Model for Building an Advanced Indonesia” as published in the Monograph Book (Andari & Ella, 2021) is a model developed by the authors as a continuation of previous research, namely "Developing a Smart Village Model for Village Development in Indonesia (Ella & Andari, 2018) and Utilization of ICT in Building a Smart Village Model for Village Development in Indonesia (Ella & Andari, 2019). This model was developed using policy analysis methods, secondary data analysis, and literature study analysis as a basis for scientific justification for the formulation of the Smart Village model.

Smart Development Initiatives in Malaysia

Malaysia's smart city development follows Vision 2020 and the Malaysia Digital Economy Blueprint. Cyberjaya serves as the flagship smart city, while Smart Selangor extends concepts state-wide, emphasizing data-driven governance and digitized services. However, rural development historically focused on agricultural modernization and poverty alleviation rather than comprehensive digital transformation. Programs like the National Fiberisation Plan primarily address connectivity gaps without integrating broader smart village concepts. Rural research emphasizes public health challenges and environmental concerns, potentially explaining bibliometric patterns showing biomedical rather than technology-focused publications.

Smart Development Initiatives in Japan

Japan's smart city initiatives align with Society 5.0, envisioning a super-smart society that integrates cyberspace and physical space through AI, robotics, and IoT. Super Smart Cities focus on disaster resilience, energy efficiency, and an aging society. Rural depopulation prompted exploration of digital villages within regional revitalization discussions, though implementation remains limited. Rural areas face aging populations, economic decline, and deteriorating infrastructure. While technological solutions like agricultural automation and telemedicine are proposed, integration of technology with social science perspectives on community sustainability remains incomplete.

Theoretical Framework for Comparative Analysis

This study draws on policy transfer and innovation diffusion theories, explaining how ideas move across boundaries and adapt to contexts. Policy transfer recognizes that successful adoption requires contextual adaptation, not direct copying. Smart city and village concepts diffuse internationally, but understanding and implementation vary based on local institutions, politics, economics, and culture. "Glocalization" captures tension between global standardization and local adaptation needs. Path dependence theory suggests that historical choices and institutional arrangements shape how new concepts are incorporated, with countries at different development stages facing distinct challenges influencing research attention.

The Smart Village Model is designed to address village development challenges like poverty and unemployment by fostering independent, efficient, and sustainable local services. It integrates four key dimensions, village resources, appropriate technology, service chains, and institutions, to improve community welfare and accelerate the transition of villages to an independent status, supporting national development goals. However, the lack of integrated measurement frameworks for Smart Cities and Villages highlights the need for glocalized indicators that blend global standards with local contexts. International cooperation and adapted measurement tools are essential for ensuring these initiatives are effective, relevant, and sustainable.

RESEARCH METHODS

Data Collection Methods

This research employed bibliometric analysis using the Scopus database, selected for comprehensive peer-reviewed coverage and standardized metadata. Data collection occurred November 15-20, 2024. Search strategies identified synonyms for Smart City and Smart Village concepts, focusing on technology-enabled development. Smart City Boolean string: TITLE-ABS-KEY ("smart city" OR "digital city" OR "connected city" OR "intelligent city" OR "sustainable city" OR "green city" OR "resilient city" OR "eco city" OR "smart urban governance" OR [additional 15 terms]) AND AFFILCOUNTRY (Indonesia OR Malaysia OR Japan). Smart Village Boolean string: TITLE-ABS-KEY ("smart village" OR "digital village" OR "connected village" OR "intelligent village" OR "sustainable village" OR "eco village" OR "resilient village" OR "kampung Malaysia" OR [additional 12 terms]) AND AFFILCOUNTRY (Indonesia OR Malaysia OR Japan). Inclusion criteria: peer-reviewed journal articles, conference papers, and review articles published through October 2024 in English and national languages (Bahasa Indonesia, Bahasa Melayu, Japanese). Exclusion criteria: book chapters, editorials, letters, erratum notices, and publications without clear geographic affiliation. Duplicate removal followed three stages: Scopus built-in detection, Mendeley-based DOI/title/author matching, and manual verification for ambiguous cases, removing 47 entries from 1,882 documents, yielding 1,835 unique publications. **Table 1** presents publication counts from database inception through October 2024: Indonesia (792 Smart City, 255 Smart Village), Malaysia (398 Smart City, 430 Smart Village), Japan (645 Smart City, 28 Smart Village)

Table 1.
Synonyms of "Smart City" and "Smart Village"

Category	Synonym	Indonesia	Malaysia	Japan
Smart City	Digital City; Connected City; Intelligent City; Wired City; Tech-Enabled City; E-City; Knowledge City; Innovation City; Cognitive City; Ubiquitous City; Information City; Sustainable City; Green City; Resilient City; Eco City; Low Carbon City; Future City; Livable City; Smart Urban Governance; Digital Urban Infrastructure; Urban Innovation Hub; Urban 4.0; Smart City.	792	398	645
Smart Village	Smart Rural; Digital Village; Connected Village; Intelligent Village; E-Village; Tech-Enabled Village; Sustainable Village; Innovative Village; Eco Village; Resilient Rural Community; Smart Rural Community;	255	430	28

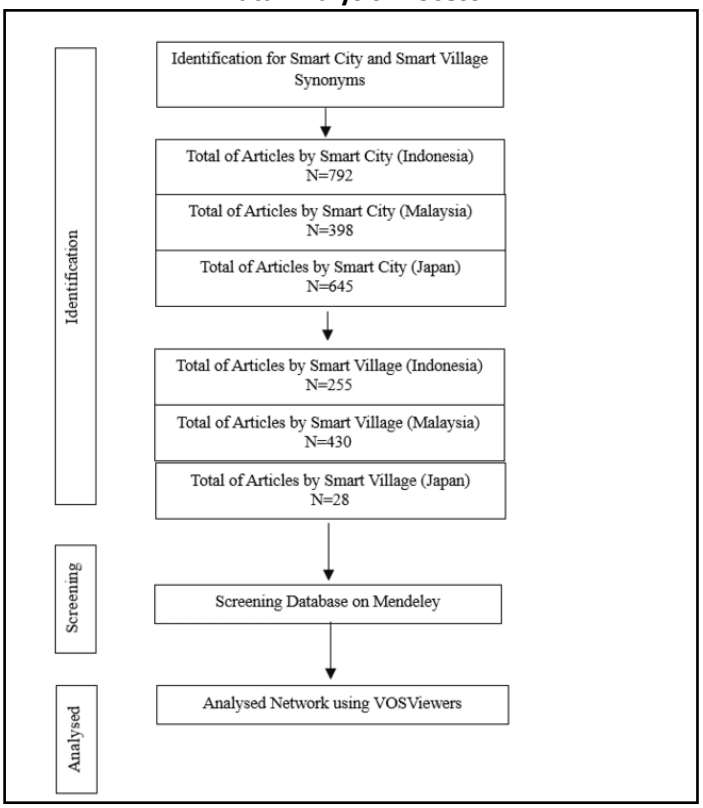
Category	Synonym	Indonesia	Malaysia	Japan
	Integrated Rural Development Village; Smart Governance Village; Digital Governance Village; E-Governed Rural Area; Village 4.0; Resilient Village; Smart Village; Rural Digital; Kampung Malaysia;			

Source: analyzed by researchers

Data Analysis

Bibliometric analysis provides objective insights into national research priorities by examining publication volume, keyword frequency, and co-occurrence patterns. This method indicates topics deemed significant for investigation and funding, with Scopus-indexed analysis ensuring rigorous quality standards. It strongly correlates with funding allocation, policy focus, and scholarly impact. Using VOS Viewer 1.6.19, documents were analyzed through bibliographic coupling and keyword co-occurrence, with minimum occurrence thresholds set at 5 for Smart City networks and 3 for Smart Village networks. Clustering utilized a resolution parameter of 1.0, generating three visualizations: network, overlay, and density. **Figure 1** outlines the analysis workflow, which began with collecting relevant articles on Smart City and Smart Village concepts. Using VOS Viewer, a network of keywords and publications was constructed. Total link strength measures the connectivity of items, indicating their interrelationships. Clusters were defined by closely related nodes, with the number of clusters increasing as the resolution parameter rises, with colors indicating cluster assignments in the visualizations (Van Eck & Waltman, 2014, 2017).

Figure 1.
Data Analysis Process



Source: analyzed by researchers

Methodological Considerations and Limitations

The selection of Scopus as the primary database provides comprehensive coverage essential for bibliometric analysis, with 25,000+ active titles, but favours English-language publications and established journals, potentially underrepresenting national-language or regional publications. Despite limitations, Scopus offers optimal standardized coverage for cross-national comparison. Keywords were iteratively refined, balancing comprehensiveness and specificity, though selection involves subjective judgment. Terms included English and national languages ("kampung" for Malaysia). Unexpected findings were verified through supplementary searches. Bibliometric analysis carries inherent biases: publication bias (not all research is published), citation bias (prominence factors), language bias (non-English under-representation), temporal lag (publication delays), and volume-quality disconnect. Transparent reporting and triangulation with policy analysis address these limitations. Malaysian Smart Village findings were verified through alternative searches ("Malaysia AND rural AND technology," "Malaysia AND village AND digital"), confirming Scopus-indexed Malaysian rural publications focus on public health rather than technology, though relevant research may exist in non-indexed repositories.

RESULTS AND DISCUSSIONS

RESULT BIBLIOMETRIC ANALYSIS

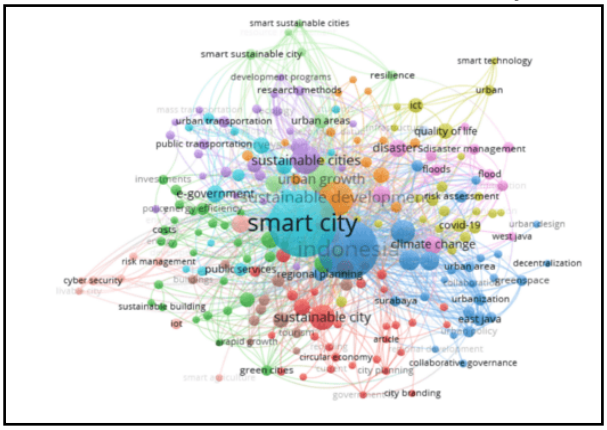
Smart City

a) Indonesia's Perception

An analysis of VOS Viewer related to Smart Cities indexed by Scopus in Indonesia reveals that there are 221 keywords grouped into 11 clusters. The analysis of occurrences and total link strength shows that the most prominent terms are "Smart City," "Sustainable Development," "Sustainable Cities," and "Urban Growth," all of which demonstrate high occurrence rates and significant total link strength.

Analysis conducted with VOS Viewer identified several key findings, as shown in Figure 2. These include network, overlay, and density visualizations. In the network visualization, frequently occurring topics are represented, with the size of each topic circle indicating the volume of related research or publications. Larger circles correspond to topics with more associated studies, while smaller circles indicate fewer studies. Colors distinguish topic cluster groups, and the proximity of lines between topics reflects the strength of their connections.

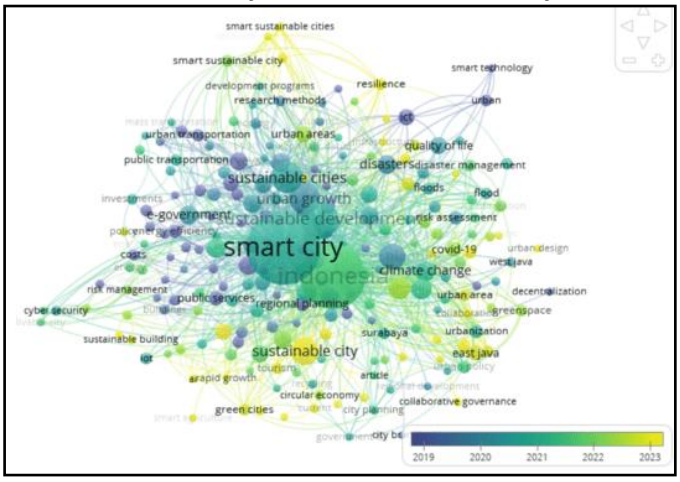
Figure 2.
The Result of Network Visualization Smart City Indonesia



Source: analyzed by researchers via VOS Viewer

The overlay visualization in Figure 3 illustrates the density of research topics through a color gradient from blue to green to yellow. Blue indicates topics with the lowest research scores, signifying areas studied in earlier years. In contrast, yellow highlights more recent research areas. Within the context of Smart Cities in Indonesia, studies associated with the keywords "Smart City," "E-Government," and "ICT" represent older research, particularly prevalent around 2019. In comparison, topics involving "Green Cities," "Smart Sustainable Cities," and "Collaborative Governance" have emerged more recently and are considered newer research areas.

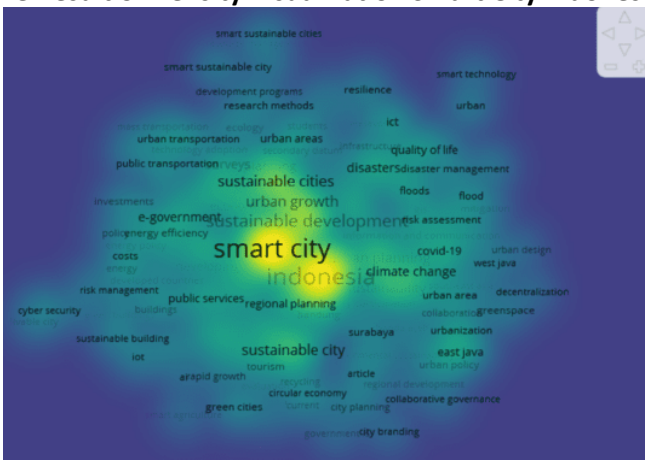
Figure 3.
The Result of Overlay Visualization Smart City Indonesia



Source: analyzed by researchers via VOS Viewer

Density visualization, as shown in Figure 4, closely resembles overlay visualization and is frequently identified by this term. In density visualization, research topics are represented using a colour gradient ranging from blue to green to yellow. Topics positioned closer to blue indicate lower significance, whereas those nearer to yellow denote higher significance. The density visualization analysis reveals that research topics such as Smart Cities in Indonesia, Livable Cities, and Smart Agriculture have been investigated infrequently. Conversely, topics related to Urban Growth and E-Government have received extensive scholarly attention in Indonesia.

Figure 4.
The Result of Density Visualization Smart City Indonesia

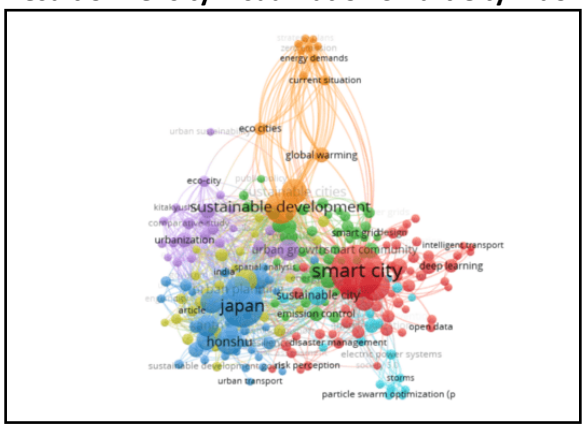


Source: analyzed by researchers via VOS Viewer

b) Japan's Perception

An analysis of Smart Cities publications indexed by Scopus in Japan identified 216 keywords organized into 7 clusters. Key terms like "Smart City," "Sustainable Development," "Urban Planning," and "Urban Development" showed high occurrences and strong link strength, highlighting their significance. Data analysis with VOS Viewer provided insights through network, overlay, and density visualizations. Figure 5 illustrates a network visualization where topic size corresponds to the number of related studies; larger circles indicate more publications. Colors represent different clusters, and closer lines indicate stronger relationships. In this visualization, Smart Cities closely connects with Sustainable Development and Sustainable Cities in Japan.

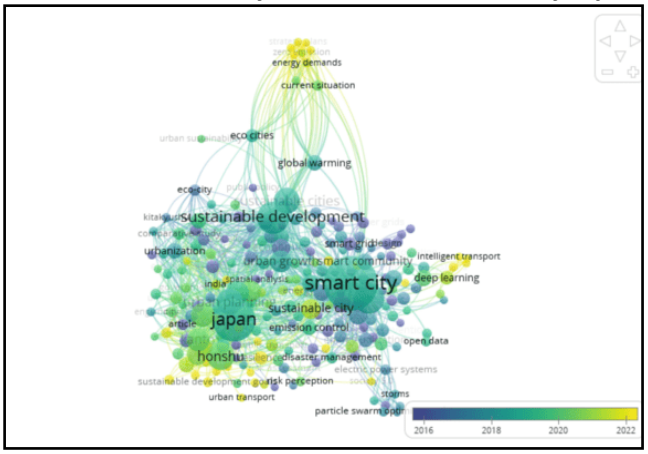
Figure 5.
The Result of Density Visualization Smart City Indonesia



Source: analyzed by researchers via VOS Viewer

The overlay visualization in Figure 6 indicates that topics are colored from blue (indicating the lowest research density) to green and up to yellow (indicating the highest research density). If a topic is colored blue, it means that research on that topic was conducted in previous years. Conversely, a yellow color indicates that research on that topic is more recent. Research topics focused on Smart Cities in Japan have been extensively studied, particularly in 2016, with key areas of focus including Smart Grid, Urbanization, and Disaster Management. In contrast, topics related to Digital Villages, associated with keywords like Energy Demands, Sustainable Development, and Urbanization, represent newer areas of research that emerged in 2022.

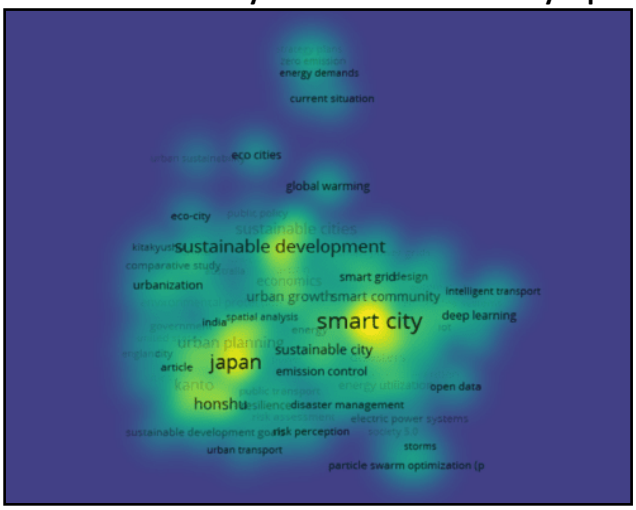
Figure 6.
The Result of Overlay Visualization Smart City Japan



Source: analyzed by researchers via VOS Viewer

In density visualization, as shown in Figure 7, topics are represented using a color gradient that ranges from blue to green to yellow. Research topics that appear closer to blue indicate a lower significance, while those closer to yellow signify a higher importance for that topic. According to the findings from the density visualization analysis, research topics related to Smart Cities, Energy Planning, Urban Sustainability, and Electric Power Systems are still relatively rare.

Figure 7.
The Result of Density Visualization Smart City Japan

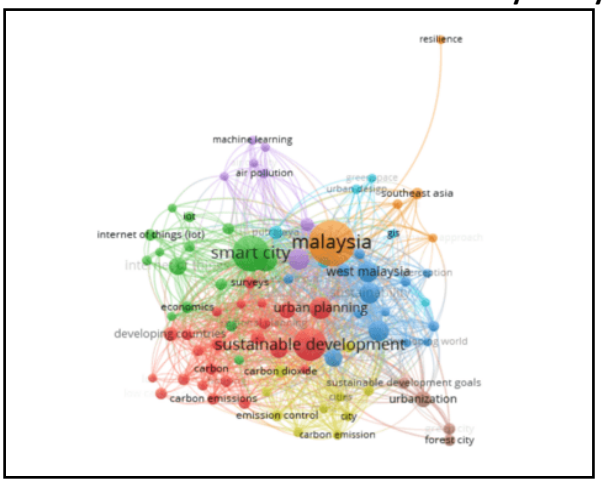


Source: analyzed by researchers via VOS Viewer

c) Malaysia's Perception

An analysis of publications on smart cities in Malaysia, as indexed by Scopus, highlights 84 keywords categorized into 6 clusters. Key terms such as 'Smart City', 'Sustainable Development', and 'Urban Planning' demonstrate their essential role in this field. The network visualization in Figure 8 shows strong connections between smart cities and themes like sustainable development and urban challenges, suggesting areas for future research. Interestingly, the concept of "resilience" is not yet linked to these discussions, indicating a potential gap for further exploration.

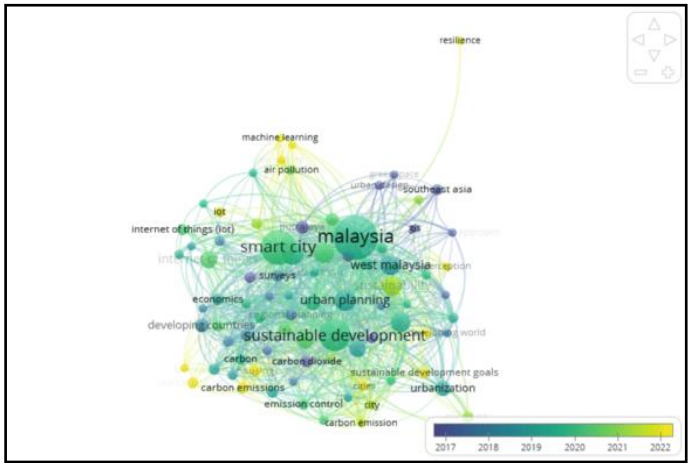
Figure 8.
The Result of Network Visualization Smart City Malaysia



Source: analyzed by researchers via VOS Viewer

In Figure 9**,** the overlay visualization clearly highlights that the topics depicted in blue, which hold the lowest research scores in Malaysia, are focused on developing countries and green spaces. Extensive research has been conducted on these essential areas in the context of smart cities, particularly from 2017 to 2018. In contrast, the colors shifting from green to yellow signify a robust and growing body of research. Moreover, the connection between "carbon emission resilience" and "machine learning" has emerged as a critical focus in smart city publications in Malaysia as of 2022, showcasing the cutting-edge developments in this field.

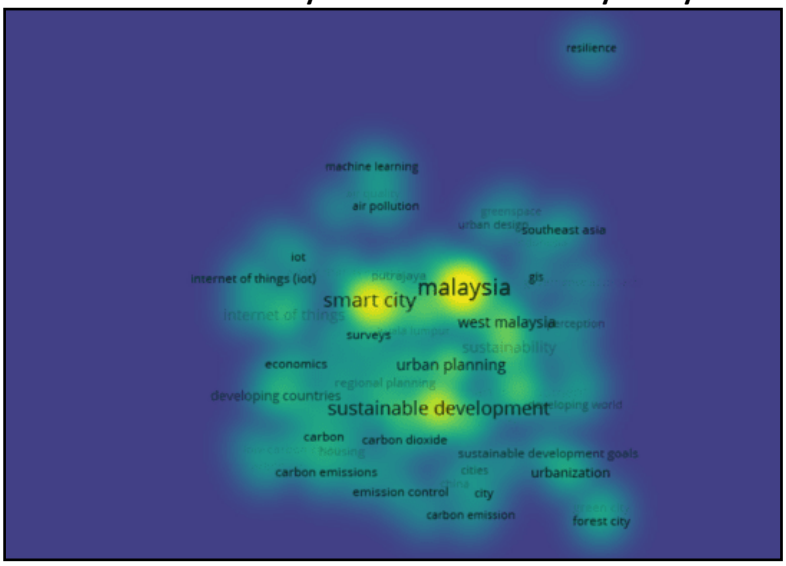
Figure 9.
The Result of Overlay Visualization Smart City Malaysia



Source: analyzed by researchers via VOS Viewer

In Density Visualization, terms that lean toward blue clearly indicate areas with limited research, whereas those closer to yellow show a significant volume of investigation. The analysis results unequivocally reveal that topics related to smart cities in Malaysia—such as greenspace, housing, and regional planning—are underexplored. In stark contrast, research on sustainable development and sustainability is robust and well-documented. The density visualization can be seen in Figure 10 below.

Figure 10.
The Result of Density Visualization Smart City Malaysia



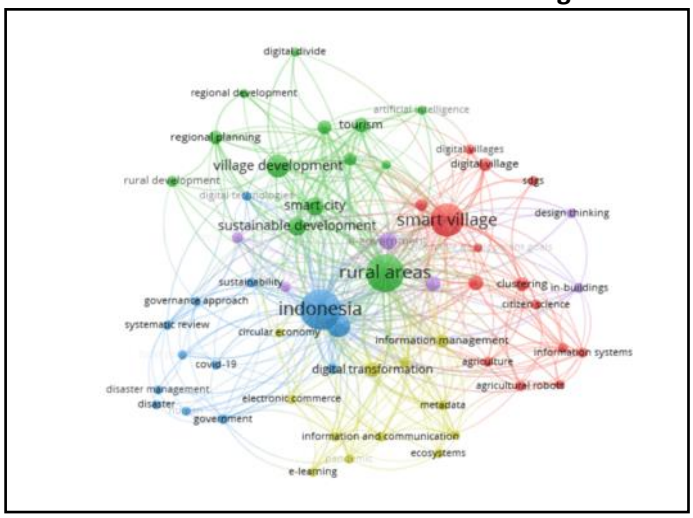
Source: analyzed by researchers via VOS Viewer

Smart Village

a) Indonesia's Perception

The bibliometric analysis of Indonesian Smart Village research, visualized through VOS viewer, reveals distinct thematic clusters and strong connections. Key keywords like "sustainable development," "digital transformation," and "rural development" dominate the discourse. Link strength metrics show robust associations between terms such as "smart city" and "regional planning," as well as "digital village" and "public services." The network analysis highlights five interconnected thematic clusters, with "sustainable development" as the most influential node bridging digital agriculture/governance, socio-economic resilience, and crisis management, emphasizing its essential cross-cutting role.

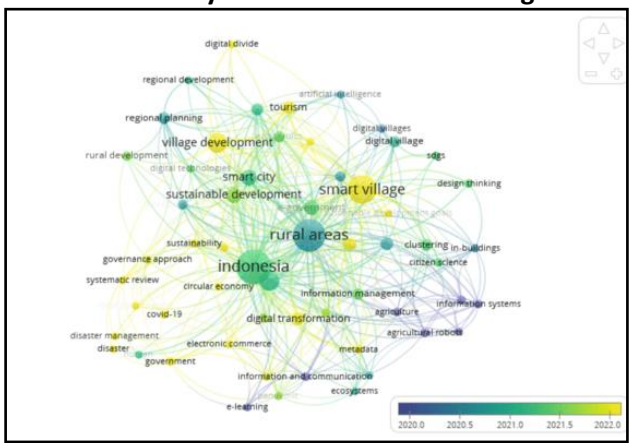
Figure 11.
The Result of Network Visualization Smart Village Indonesia



Source: analyzed by researchers via VOS Viewer

The overlay visualization of Indonesian Smart Village research, mapped using VOS Viewer, illustrates the evolution of research priorities from 2020 to 2022. In 2020, themes focused on urgent crisis responses, emphasizing "COVID-19," "disaster management," and "e-learning." By mid-2021, topics shifted towards building digital infrastructure, highlighting "digital technologies" and "information management." In 2022, research themes reflected specialized technological integration, including "digital transformation," "electronic commerce," and "agricultural robots," indicating a move toward economic digitization and precision agriculture. Persistent themes like "sustainable development" and "regional planning" remained significant, while the isolated mention of "digital divide" in 2020 underscored concerns about equity in digital transformation narratives.

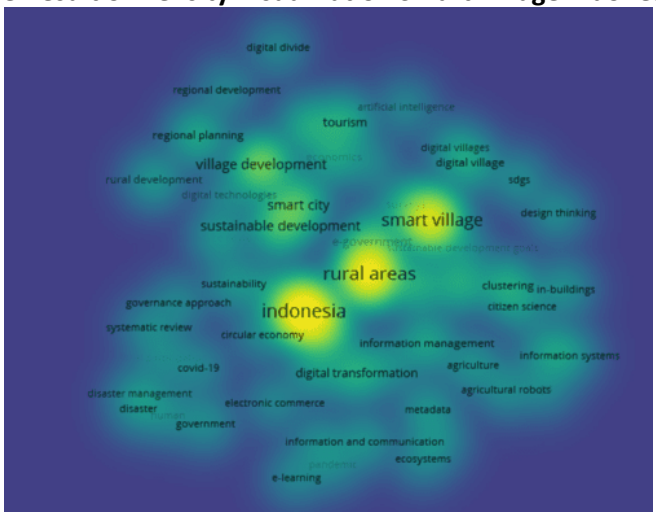
Figure 12.
The Result of Overlay Visualization Smart Village Indonesia



Source: analyzed by researchers via VOS Viewer

The density visualization of research on Indonesian Smart Villages highlights key knowledge hubs and gaps. High-density areas, shown in warm colors, cluster around vital themes like "sustainable development," "digital transformation," and "smart village," indicating strong conceptual connections, particularly in "digital technologies," "rural development," and "information management." A notable secondary area focuses on crisis-responsive issues such as "COVID-19," "e-learning," and "disaster management," emphasizing the need for research during the pandemic. Additionally, interest in "agricultural robots" and "electronic commerce" is growing as emerging high-density nodes. The results are illustrated in Figure 13 below.

Figure 13.
The Result of Density Visualization Smart Village Indonesia



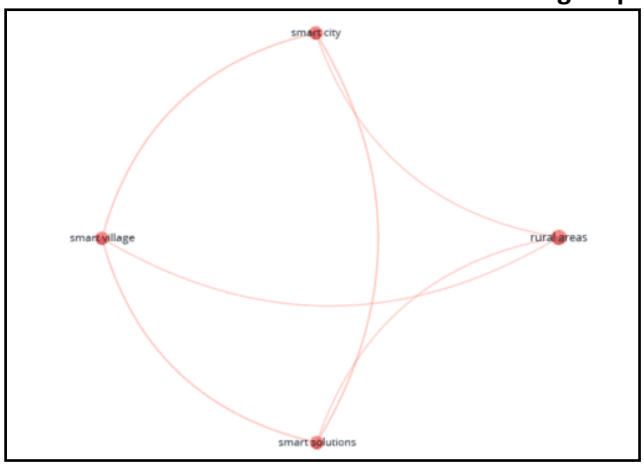
Source: analyzed by researchers via VOS Viewer

b) Japan's Perception

The analysis of Japan's Smart Village research reveals clear themes and strong connections. Key terms like "sustainable development," "digital transformation," and "rural development" are important. Strong ties exist between "smart city" and "regional planning," and "digital village" and "public services," highlighting Japan's focus on integrating urban and rural areas with technology. However, the low link strength for "digital divide" shows that equity issues need more attention. The visual map shows a strong core centered on "Smart City," "Smart Solutions,"

and "Smart Village," but "Rural Areas" is on the edge. This gap indicates that rural challenges are not fully integrated into discussions on smart technology. Additionally, the absence of terms like "sustainable development" suggests Japan's focus on technology may overlook social and environmental concerns.

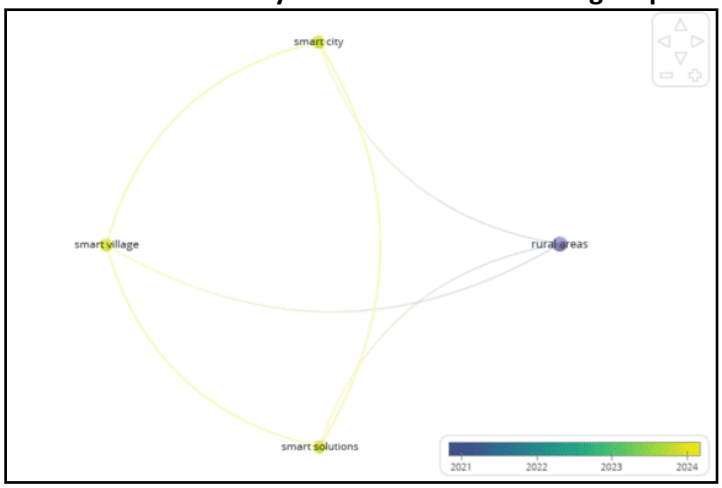
Figure 14.
The Result of Network Visualization Smart Village Japan



Source: analyzed by researchers via VOS Viewer

The overlay visualization of Japanese Smart Village research from 2021 to 2024 shows a marked shift from foundational rural contexts to integrated technological frameworks. In the early stages (2021-2022), the focus was on "rural areas," addressing challenges like depopulation and infrastructure issues. By 2023-2024, the emphasis shifted to interconnected concepts of "smart city," "smart village," and "smart solutions," highlighting Japan's commitment to urban-rural technology transfer. The proximity of these terms indicates a strong convergence between urban and rural smart models, with "smart solutions" linking theoretical ideas with practical applications. However, the transition from rural-focused terminology to tech-driven terms raises concerns about continuity and the need for technology to be adapted to the unique socio-economic contexts of rural communities. This visualization suggests that while Japan prioritizes scalable innovation, it may overlook essential local adaptations in technology deployment.

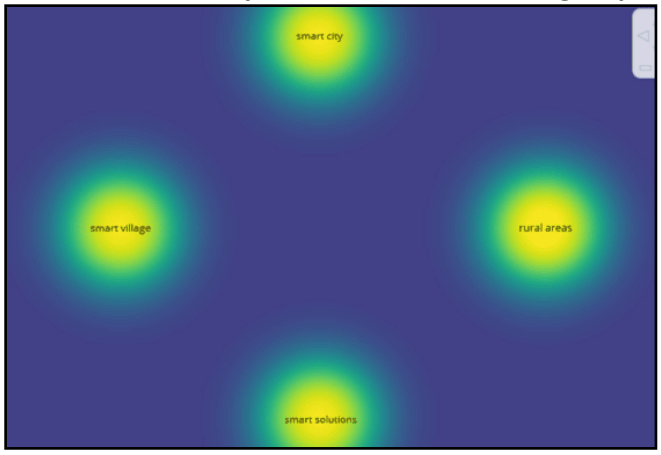
Figure 15.
The Result of Overlay Visualization Smart Village Japan



Source: analyzed by researchers via VOS Viewer

In Figure 16, the density visualization of Japanese Smart Village research shows a polarized landscape, with a concentrated core around "smart city," "smart village," and "smart solutions" (warm colors), underscoring a focus on scalable technological frameworks. In contrast, "rural areas" appear as a low-density island (cool colors), indicating a lack of attention to socioeconomic issues like depopulation and aging communities. The absence of terms such as "sustainability," "governance," and "community participation" suggests a preference for technology-centered solutions that neglect rural realities. This highlights a critical disconnect in which Japan's advancement in smart systems does not translate to addressing rural challenges. Future research should bridge this gap, integrating technological solutions into local socio-ecological contexts.

Figure 16.
The Result of Density Visualization Smart Village Japan



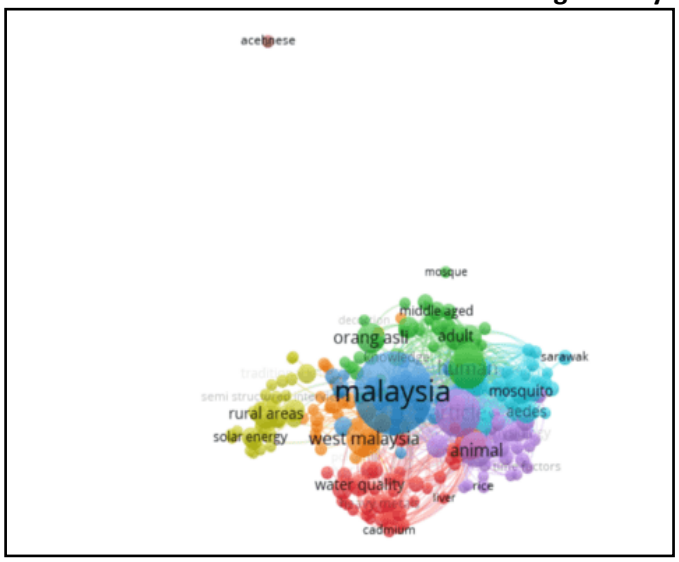
Source: analyzed by researchers via VOS Viewer

c) Malaysia's Perception

The bibliometric analysis of Malaysian research, visualized through VOS viewer, clearly reveals a strong biomedical focus, rather than the expected themes associated with Smart Villages as seen in Table 7. The dominant keywords "Malaysia" (294 occurrences), "Article" (100), and "Human" (72) underscore a significant emphasis on medical research. The robust link strengths between "Human" and "Animal" (1,577) and "Mosquito" and "Aedes" (306) further cement the concentration on vector-borne diseases. While "Malaysia" serves as a geographical anchor with an impressive link strength of 1,732, its connections overwhelmingly point toward clinical terminology, such as "Controlled Study" (284), rather than rural development concepts. Notably, key Smart Village terms like "digital village," "rural development," and "sustainability" are completely absent from the discourse. This analysis firmly establishes the focus of Malaysian research in the biomedical field.

The network visualization of Malaysian research clearly reveals a fragmented intellectual landscape comprising two distinct clusters: a dominant biomedical/environmental cluster and an isolated rural development cluster. The biomedical sector showcases strong connections in vector-borne disease research and environmental toxicology, particularly between "mosquito" and "aedes", as well as "animal" and "cadmium." Serving as the central hub, "Malaysia" effectively links these themes to key geographical nodes such as "West Malaysia" and "Sarawak." This structured network underscores the nation's focus and expertise in these critical areas in Figure 17 below.

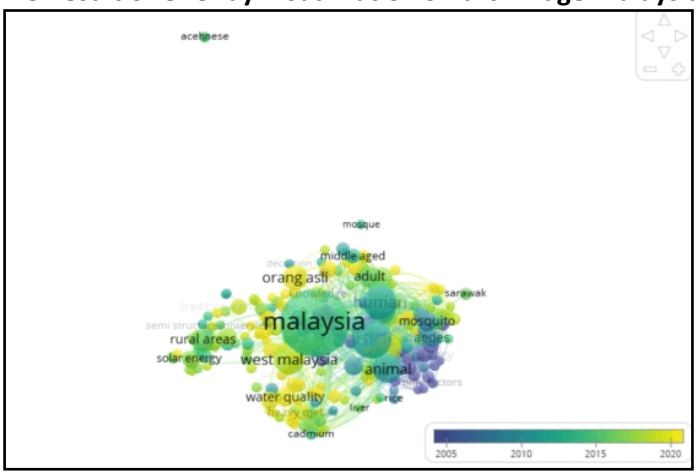
Figure 17.
The Result of Network Visualization Smart Village Malaysia



Source: analyzed by researchers via VOS Viewer

The overlay visualization of Malaysian research from 2005 to 2020, as appears in Figure 18**,** clearly demonstrates a strong and consistent focus on biomedical and environmental issues, with limited movement towards Smart Village themes. During the initial phase from 2005 to 2010, studies decisively concentrated on public health and environmental toxicology, particularly in relation to mosquitoes, cadmium contamination, and water quality. From 2010 to 2015, research confidently expanded its scope to include geographic regions such as Sarawak and West Malaysia, as well as key demographic factors like middle-aged and adult populations. This shift underscores an important emphasis on region-specific health studies that reflect the unique challenges faced in different areas.

Figure 18.
The Result of Overlay Visualization Smart Village Malaysia

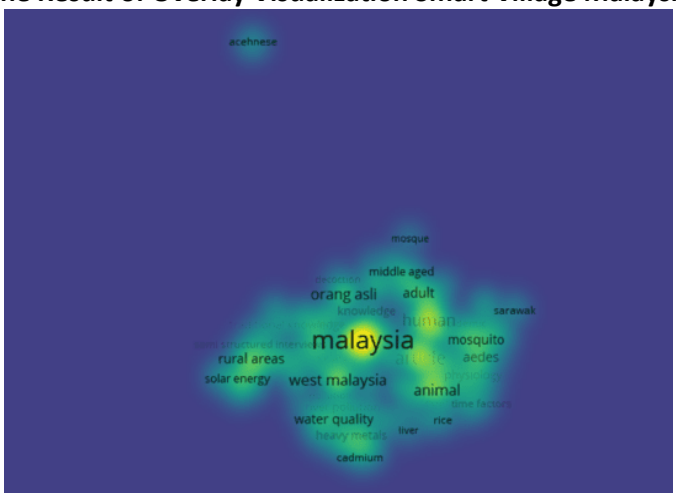


Source: analyzed by researchers via VOS Viewer

The density visualization of Malaysian research highlights a significant imbalance, with a strong focus on biomedical and environmental themes, while Smart Village scholarship is largely neglected. Three main hotspots emerge: Disease Ecology, which concentrates on "mosquito," "aedes," and "Malaysia"; Toxicology, involving "cadmium," "heavy metals," and "water quality"; and Regional Health, linking "West Malaysia" and "Sarawak" with demographics such as

"middle-aged" and "adult." These areas reflect Malaysia's strengths in public health and environmental science. However, "orang asli" (indigenous communities) appears as a low-density island, disconnected from technology, sustainability, or governance, indicating a superficial understanding of rural social issues. The density visualization of Smart Village in Malaysia can be seen in Figure 19 below.

Figure 19.
The Result of Overlay Visualization Smart Village Malaysia



Source: analyzed by researchers via VOS Viewer

Mapping Research Trends on Smart Cities and Smart Villages in Indonesia, Malaysia, and Japan Through Bibliometric Analysis

a) Smart City

Research on Smart Cities in all three countries demonstrates significant engagement with sustainable development principles. Keywords including “Sustainable Development,” “Sustainable Cities,” “Urban Planning,” and “Climate Change” are prominent and interconnected, reflecting the integration of global Smart City discourse into national research agendas. Despite this commonality, each country exhibits distinct approaches and research emphases.

In Indonesia, the Smart City research network is dense and fragmented into 11 clusters, reflecting diverse research topics influenced by varied local initiatives. VOS viewer analysis reveals 221 keywords in 11 clusters (Table 2), with "Smart City," "Sustainable Development," "Sustainable Cities," and "Urban Growth" most prominent. Network, overlay, and density visualizations (Figures 2-4) show evolution from e-government and ICT foundations (2019) toward recent green city, smart sustainable city, and collaborative governance emphasis. This trajectory reflects a shift from technology adoption to environmental and participatory governance integration. Livable city and smart agriculture remain underexplored, presenting research opportunities. Meanwhile, Smart City research in Japan appears to be more consolidated and focused, with only 7 clusters. Analysis identifies 216 keywords in 7 clusters, emphasizing "Smart City," "Sustainable Development," "Urban Planning," and "Urban Development." Figures 5-7 reveal a systematic infrastructure-engineering orientation focused on established metropolitan areas (Honshu, Kanto, Tokyo). Disaster management represents established research (2016), while Digital Village emerges recently (2022), connecting to energy demands and urbanization early indication of urban-rural linkage discourse responding to depopulation challenges. Malaysia presents a simpler Smart City map with six clusters. While

sustainability dominates similarly to other countries, distinctive features include "Developing Countries" and "Machine Learning". The carbon emission resilience-machine learning connection (2022) indicates AI utilization for sustainability. Resilience concepts show weak Smart City integration, suggesting a development opportunity. Greenspace and regional planning remain underexplored (Figures 8-10).

b) Smart Village

The Smart Village research mapping highlights significant differences among the three countries, reflecting varying priorities and approaches to rural development. Indonesia demonstrates a dynamic and well-integrated Smart Village research landscape, organized into five interconnected clusters. Analysis reveals 5 interconnected clusters with "Sustainable Development" bridging digital transformation, rural development, public services, and regional planning. Strong, smart village-smart city connection suggests researchers view concepts as mutually supportive for addressing rural-urban divide. Research evolved from COVID-19 emergency responses (2020) through digital infrastructure (2021) to economic enhancement (2022), reflecting responsive alignment with national needs. The digital divide theme appears but remains weakly connected, highlighting the equity challenge gap.

In contrast, Japan's Smart Village research map is minimalist and isolated, centering on the core triad of "Smart City," "Smart Village," and "Smart Solutions." Minimalist map centers on "Smart City," "Smart Village," and "Smart Solutions". "Rural Areas" appears peripherally, indicating a disconnect. Research focuses on general smart solutions without deep rural socio-economic integration (depopulation, aging). Community participation and governance themes are absent, reinforcing a technocentric top-down approach. Temporal analysis shows rural areas as an older theme (2021-2022), smart triad as newer (2023-2024), suggesting a problem-to-solution shift, though integration remains limited. Most striking are the mapping results for Smart Village in Malaysia. Analysis reveals a biomedical focus rather than Smart Village technology themes. Dominant keywords: "Malaysia," "Human," "Animal," "Mosquito," "Aedes." Strong biomedical/environmental connections in vector-borne disease and toxicology research. Smart Village technology terms ("digital village," "rural development," "sustainability") are completely absent. Verification searches ("Malaysia AND rural AND technology," "kampung") confirmed Scopus-indexed Malaysian rural publications emphasize public health over technology, though relevant research may exist in non-indexed repositories.

Table 2 below presents an overview of publication trends related to Smart Cities and Smart Villages in Indonesia, Malaysia, and Japan.

Table 2.
Publication Trends on Smart Village: Comparing Indonesia, Malaysia, and Japan

Smart Village			
Aspects	**Indonesia**	**Malaysia**	**Japan**
Focus and Maturity of Discourse	Comprehensive and Evolutionary. Well integrated with Smart City. Has a clear journey: from emergency response to digital foundation and digital economy.	Not Detected as a Technological Concept. Academic discourse is dominated by biomedical and public health research in rural areas.	Minimalist and technocentric. Seen as an extension of Smart City. Disconnected from the specific socio-demographic context of rural areas.

Smart Village			
Aspects	**Indonesia**	**Malaysia**	**Japan**
Keywords	Sustainable Development, Digital Transformation, Rural Development, Public Services, COVID-19, E-Commerce	Malaysia, Human, Animal, Mosquito, Aedes (predominantly biomedical). No keywords related to rural technology.	Smart City, Smart Village, Smart Solutions, Rural Areas (separate).
Number and Interconnection of Clusters	High and Integrated (5 clusters). "Sustainable Development" serves as a bridge between themes.	Irrelevant. The network formed is in the field of biomedicine, not Smart Village.	Very Simple and Isolated. Only one small cluster centered on the "smart" triad.
Connection with Smart City	Very strong. Seen as two sides of the same coin for equitable development.	None. The concept of Smart Village technology does not appear in the research map.	Very strong but one-sided. Smart Village is seen solely as the application of urban solutions to rural areas.
Current Trends	Digital Transformation, Electronic Commerce, Agricultural Robots.	Trends related to public health and the environment (2005-2020).	The development of the "Smart City, Smart Village, Smart Solutions" triad (2023-2024).
Aspects that have not been explored	The handling of the "Digital Divide" still seems to have weak connections with the main theme.	Smart Village, as a technology-based development concept, has not become mainstream research.	Technological solutions are not integrated with real rural issues (depopulation, aging population).

Source: analyzed by researchers

Theoretical Interpretation of Findings

Indonesia's fragmented 11-cluster structure reflects decentralization literature predictions: devolved governance creates innovation centers but challenges coordination. Strong smart city-village integration illustrates cross-sectoral policy coordination, recognizing urban-rural interdependence. Evolution toward collaborative governance shows maturation from technology-push to socio-technical perspectives. Japan's consolidated structure and technocentrism demonstrate path dependence: engineering tradition privileges technical solutions over social participation. Weak smart village-rural challenge integration suggests domain specialization where technical and social experts operate independently. Malaysia's biomedical rural research dominance reflects disciplinary path dependencies. Public health strength addressing genuine challenges (dengue) hasn't extended to rural technology domains, indicating separate policy domains with distinct research communities

Systematic Cross-Country Comparison

Table 3.
Comparative Analysis of Research Characteristics and Theoretical Implications

Dimension	Indonesia	Malaysia	Japan
Theoretical Interpretation	Decentralized policy laboratories creating diverse innovations	Disciplinary path dependence concentrating on rural	Path-dependent technocentrism, privileging engineering

	with coordination challenges	research in the public health domain	solutions over socio-technical integration
Key Strengths	Strong urban-rural research integration; responsive evolution from technology to governance focus; contextual sensitivity to local challenges	Advanced computational methods for sustainability; emerging AI applications; strong public health research capacity in rural contexts	Systematic infrastructure focus; mature urban smart city implementation; sophisticated technical systems integration
Critical Gaps	Fragmentation limits knowledge synthesis; underexplored livable city and smart agriculture dimensions; the digital divide is weakly integrated	Complete absence of technology-focused smart village research; weak resilience integration in smart city discourse	Disconnect between rural challenges and technology solutions; limited community participation emphasis; weak rural socio-demographic integration
Primary Policy Recommendation	Create national knowledge coordination platforms; fund multi-regional comparative research; develop flexible measurement frameworks	Build smart village research capacity through dedicated centers; map existing rural technology initiatives; establish academic-practitioner partnerships	Fund interdisciplinary rural technology research; shift toward community-engaged approaches; integrate technology with comprehensive rural development
Implications for Measurement Frameworks	Frameworks should allow regional adaptation while enabling national comparison	Need to establish foundational metrics before pursuing advanced measurement	Should balance technical indicators with social sustainability and community well-being metrics

Source: analyzed by researchers

CONCLUSIONS

This bibliometric analysis reveals substantial differences in Smart City and Smart Village research across Indonesia, Malaysia, and Japan. All show Smart City research linked to sustainable development, though approaches differ. Indonesia shifted from e-government to green development and collaborative governance with notable urban-rural integration. Japan concentrates on infrastructure engineering with a technocentric orientation, conceptualizing Smart Villages as Smart City extensions, limiting rural socio-demographic adaptation. Malaysia shows minimal Smart Village technology engagement, with rural research focused on biomedical and public health issues. Results underscore the need for integrated context-sensitive measurement indicators aligning global frameworks with local conditions.

Policy Recommendations. Indonesian policymakers should establish coordination platforms enabling cross-regional learning while funding comparative studies. Japanese policymakers must bridge technology-rural reality gaps through interdisciplinary programs and community-engaged research. Malaysian policymakers should conduct baseline mapping and establish dedicated research centers to build smart village capacity.

Study Limitations. Scopus indexing captures primarily peer-reviewed articles, missing local journals, government reports, and gray literature, particularly affecting Malaysian Smart Village

interpretation. Language bias favors English publications despite multi-language searches. Synonym selection, though comprehensive and verified, may miss alternative terminology. VOS viewer parameter choices, while tested for robustness, involve subjective judgment. Temporal analysis reflects publication dates, not research conduct dates. Bibliometric patterns reveal publication trends but cannot directly assess research quality or policy impact.

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