

From Smart Village to Digital Village: Bibliometric Mapping of Conceptual Evolution, Research Clusters, And Policy Implications (2016-2025)

*Ray Septianis Kartika
Entang Adhy Muhtar
Yanuar Farida Wismayanti*

Abstract: This study aims to systematically map the conceptual evolution, thematic clusters, and policy implications of Smart Village and Digital Village research during the period 2016-2025. Using a bibliometric approach, publication data were retrieved from the Scopus database and analyzed using VOSviewer to examine co-occurrence networks, thematic evolution, and research clustering. Hasil data bibliometric sourced from 131 conference papers, 130 articles, 42 book chapters, 17 conference reviews, and 4 types of books. The results reveal a clear conceptual shift from technology-centric Smart Village frameworks toward more integrated Digital Village paradigms emphasizing governance, service delivery, sustainability, and community empowerment. Five major research clusters were identified: (1) digital governance and public service innovation, (2) rural economic empowerment and digital entrepreneurship, (3) infrastructure and connectivity, (4) social inclusion and digital literacy, and (5) sustainability and smart agriculture. Temporal overlay visualization indicates increasing dominance of governance, service integration, and sustainability themes after 2020. Policy implications suggest the need for integrated digital transformation frameworks, participatory governance models, capacity-building strategies, and context-sensitive rural digital policies. This study contributes to theoretical refinement, methodological advancement, and policy-oriented insights for advancing sustainable Digital Village development.

Key words: Smart Village, Digital Village, Bibliometric Mapping, Conceptual Evolution, Policy Implications, Rural Digital Transformation

INTRODUCTION

Technological developments have transformed everyday life. The technological gap is not only found in some countries, but Indonesia has experienced fluctuations in technological dynamics that have led to transformation. The bibliometric concept in this article illustrates the phenomenon of smart villages becoming digital villages. The euphoria of smart villages has transformed into digital villages. Since 2016, this metamorphosis has undergone significant changes that have altered the mindset and culture of rural areas to avoid the gap between cities and villages.

Smart villages transitioning to digital villages have become a concept that emphasizes building the independence of village governments to carry out digital transformation. The question is whether digitization in villages can alleviate development problems? (Bai, 2024). The focus is on applying the needs without being free from the use of information and telecommunications technology to improve basic service needs and empower an inclusive community to participate and not stagnate through the improvement of superior and advanced human resources.

Smart villages as implicitly autonomous regions are capable of managing their potential and village assets to develop the potential and superior products owned by the village using traditional concepts and digital technology, thereby creating innovation, creativity, and adaptability, as well as better use of information knowledge. The essence of digital rural development can encourage the improvement of the agricultural industry, improve the equitable distribution of public services, and accelerate integration between urban and rural areas (Liu et al., 2023). This article will use bibliometrics as a tool to measure the progress of the transition from smart villages to digital villages.

Conceptual evolution bibliometrics examines policy dynamics from 2016 to 2025, ranging from the use of technology to meet needs to changes in services that force the community to reform through Conceptual Evolution Bibliometric Mapping, which aims to track changes, shifts, and developments in scientific concepts over time, identify dominant themes, emerging themes, and declining themes, mapping the knowledge structure of a field, and assessing how terminology, research focus, and theoretical frameworks evolve.

During the 2016-2025 period, there has been a long transformation from smart villages to digital villages. Various policies have been introduced over the past four years, with an emphasis on SDGs and the

wise use of technology becoming strategic issues that are worth discussing.

Table 1. of Conceptual Evolution of Smart Villages and Digital Villages

Year	Villages	Focus	Conceptual	Goal	Description
2016	Smart Village	Technology and Infrastructure Rural connectivity Broadband access	Foundational Phase: Technology as Solution	Bridging the rural gap through technology	Smart Village can be assumed as a concept Digital Village is assumed to not yet exist for implementation because it has not been institutionally established
	Digital Village	Villages are viewed as objects of digitalization; technology as the main vehicle for implementing village development.	It rarely appeared as an independent concept Was still absorbed in the term smart village	Digital direction is still limited to technological fulfillment	
2017	Smart Village	Expansion Phase: Smart Services & Efficiency	It has shown limitations, and only explains: Village administration digitization Village information system	Villages with technology-based public services	Dominant Smart Village Embryonic Digital Village
	Digital Village		It rarely emerged as an independent concept Still absorbed in the term “smart village”	Still not much different from a smart village.	
2018	Smart Village	Early Transition Phase	It continues to dominate but is beginning to be criticized because technology is not an indicator for assessing the welfare of society.	Begins to lose its “pure technology” characteristics.	Transition from symbolic to functional
	Digital Village		Started appearing as an alternative concept, and emerged in relation to: Governance, Local context, Local Capacity, and Community Participation.	Paradigm shift by utilizing digital services	
2019	Smart Village	Conceptual Differentiation Phase	Serves as a technological foundation with digital transformation prerequisites	The concept began to stagnate in terms of theoretical innovation.	The concept of the Digital Village has become more practically oriented compared to Smart

Year	Villages	Focus	Conceptual	Goal	Description
	Digital Village		Increasingly characterized as governance-oriented digital transformation with a participatory approach Villages begin to be positioned as co-creators and development actors.	The distinction between “smart” and “digital” becomes more clearly defined.	Village development. Digitalization extends beyond the single-business level, encompassing both management processes and database development (Rose & Chilvers, 2018; Wolfert et al., 2014).
2020	Smart Village	Pre-Sustainability Phase or Acceleration Phase of the Crisis	It is rarely used and is no longer part of village culture to implement smart villages. Focus limited to infrastructure and services	Reducing information and digital gaps in villages Improving the quality of life of village developers (Gil-Lacruz et al., 2021) Promoting sustainable and participatory village development Supporting digital-based village economic growth	Digital Village becomes a necessity
	Digital Village		Strengthening the logical framework for digital transformation in villages Focus limited to infrastructure and services Beginning to connect with: Inclusion, Empowerment Resilience (initial)	Memberdayakan pembanguna desa untuk beradaptasi dengan era digital global Making villages “digitally active” Improving digital literacy and community capacity Integrating digital technology for public services and the economy (Barro, 2002, Li et al., 2024, Ma et al., 2024) Empowering village development to adapt to the global digital era	
2021	Smart Village	Consolidation & Early Integration Phase	The initial focus of the Smart Village program initiated by the Ministry of Villages, Disadvantaged Regions, and Transmigration is to increase village digitalization with pilot projects as the target.	Smart Village began with a roadmap for implementing pilot villages, but many have already abandoned it at the policy level. Digital Village is still in its early stages of expanding digital literacy and basic infrastructure.	Digital Village = the mainstream

Year	Villages	Focus	Conceptual	Goal	Description
			The main stages include socialization, basic training, and planning for pilot villages.		
	Digital Village		Initial focus on digitizing village development and digital infrastructure services, including internet access, digital devices, and basic literacy		
2022	Smart Village	Digital Village Ecosystem Phase	The implementation of pilot villages was carried out in several regions.	Smart Village is transitioning to a more complex pilot implementation. Digital Village focuses on basic readiness (infrastructure & literacy).	From digitization to digital transformation. (Cowie et al., 2020; Klerkx and Rose, 2020; Lajoie-O'Malley et al., 2020).
	Digital Village		Strengthening digital literacy in villages and among officials as part of the initial stages of digital transformation. Many villages have begun to utilize village funds for digital development and connectivity services.		
2023	Smart Village	Data-Driven Village Phase	The program is expanding, with many villages beginning to implement digital services (e-administration, digital communication, village collaboration). Assistance for digital village cadres is being strengthened to accelerate the adoption of digital technology.	Data-driven and sustainable digital village	Digital Village as digital-based technology development, not a project
	Digital Village		Intensification of access and connectivity provision as well as digital literacy training for village development. Increased attention to the application of technology in basic village administrative services.		
2024	Smart Village	Sustainability & Digital Inclusion Phase	The program continues with cross-development collaboration, enhanced	Smart Village is becoming more mature and focused on continuing integrated digitalization, while	Data-driven and sustainable digital villages

Year	Villages	Focus	Conceptual	Goal	Description
			implementation of technology for public services, village data (SID), digital economy, and strengthening of village human resources Some villages that have been fully digitized are being prepared as examples of smart villages	Digital Village continues to emphasize basic digital expansion throughout villages.	
	Digital Village		The main focus is to expand digitalization throughout villages as a prerequisite for Smart Villages. Many villages utilize village funds with a priority on the use of information technology and digital services for administration and public services.		
2025	Smart Village	Smart–Digital Village Convergence Phase	The government emphasizes that village digitization is the foundation for Smart Villages. Villages that have achieved digitization are promoted as Smart Villages A Digital Village competition is held to measure and encourage digital innovation in villages as progress towards Smart Villages	Positioned as the initial phase of transformation	Digital Village = maturity stage
	Digital Village		The main target for 2025 is 100% digital villages (75,265 villages) through the prioritization of village funds for information technology. The latest regulation (Kepmendesa PDTT 55/2024) combines digital/smart villages into one nomenclature, thereby formally blurring the boundaries between programs.	Smart–Digital convergence Simple AI & village service automation Villages as nodes of the national digital economy	

Sources: Compiled from various sources

This synthesis shows that the evolution of the concept doesn't represent a switch between Smart Village and Digital Village, but rather a change in their relationship. At first, Smart Village was the dominant concept with a tech-oriented focus, while Digital Village was just a part of its implementation. Over time, Digital Village developed into the foundation for village digital transformation through strengthened governance, public services, digital literacy, and community empowerment. At a more advanced stage, Smart Village is positioned as the ideal state achieved after comprehensive digital transformation takes place. Thus, the development from 2016-2025 shows a shift from infrastructure digitalization to sustainable digital transformation focused on community welfare, with the convergence of Smart Village-Digital Village as the new paradigm for village development. The synthesis of that table came up with a few key findings.

1. There's been an evolution in the paradigm from technology-driven village development to transformation-driven village development.
2. Digital Villages grow faster than Smart Villages because they are easier to implement through digitalizing administration, public services, and governance.
3. Smart Villages have shifted from a technology concept to a holistic development concept, covering governance, economy, environment, community participation, and sustainability.
4. The relationship between the two concepts is hierarchical, where Digital Village serves as the foundation, while Smart Village represents the maturity stage of village digital transformation.
5. Starting in 2025, there will be a conceptual convergence, where government policies no longer strictly separate Smart Village and Digital Village, but see both as a single spectrum of village development transformation.

The writing on development will lead to research clustering based on global issues that will be interesting and demonstrate the increasing relevance of research. The purpose of this research is to explore conceptual evolution, research clustering, and policy implications related to smart villages and digital villages.

METHODS

This research uses a literature study method with a quantitative approach employing bibliometric analysis. Clustering was done on the 2016-2025 grouping regarding smart village and digital village issues.

Bibliometrics will provide a conceptual theoretical direction that can be operationalized in this article. Based on Scopus references with the keywords 'smart village' and 'digital village,' this will provide opportunities as well as synergistic cohesion between the two concepts.

This study adopts a descriptive qualitative approach to explore and explain the analysis in depth. The main focus is to provide a comprehensive understanding of various aspects and analyses, including definitions, concepts, and their application in scientific literature. The main method in this study is an in-depth literature review of various academic sources related to development analysis. These sources include various journal-based references and reports from various relevant scientific publications from 2016 to 2025. This literature review aims to identify basic concepts, namely collecting information about the definitions, concepts, and development analysis that have been published in the latest literature and assessing the methods used, namely information about the various tools and methods used in Development analysis, including VOSviewer and Bibliometrix.

The data sources for this study are academic databases such as Google Scholar, Scopus, Web of Science, and PubMed, which were used to search for and collect relevant articles and books that refer to methodological books providing in-depth guidance on analysis, including documents from tools such as VOSviewer and Bibliometrix.

The data analysis technique used in this study is content analysis of the collected literature to identify key themes, methodologies, and tools in analysis. This process includes filtering information based on the relevance and quality of sources, as well as grouping information into main theme categories such as definitions of analysis, basic concepts, and applications. Then, data synthesis, which is integrating information from various sources to present a comprehensive picture of analysis. This includes an explanation of how analysis techniques are applied and their impact on scientific research, as well as a conceptual map to illustrate the relationship between various aspects of analysis such as basic concepts and applications.

The research results will be presented in a descriptive form that explains the analysis in depth, including definitions, concepts, and applications. This explanation will be based on the literature analysis that has been conducted.

DISCUSSION

The results of mapping and temporal analysis show that the implementation of Smart Village and Digital Village in Indonesia during the

2016-2025 period is not linear, but rather experiences a paradigm shift influenced by national policy dynamics, infrastructure readiness, and the evolution of global research focus. These findings reinforce that Smart Village and Digital Village are not identical concepts, but rather two phases of policy and implementation that are mutually reinforcing but have different orientations and mechanisms.

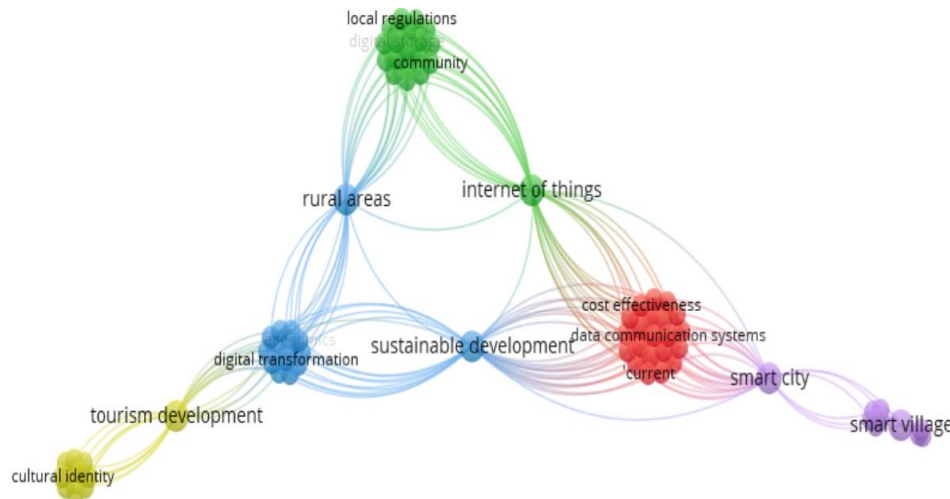


Figure 1

Sources: Digital Village Bibliometrics

In the initial phase (2016-2018), the discourse and implementation of Smart Villages in Indonesia was dominated by an infrastructure-centric approach. This was reflected in the dominance of issues related to local regulations, communities, and rural areas. The main focus of policy during this period was on providing basic connectivity, strengthening village governance, and integrating villages into the national sustainable development agenda. Smart Village was positioned as an adaptation of the Smart City concept to rural areas, with an emphasis on public service efficiency and optimization of local resources. However, this approach was still top-down and did not fully encourage data and service oriented digital transformation.

Entering the 2019-2020 period, there was a significant shift in focus along with the increasing intensity of digital transformation, the Internet of Things, and sustainable development. In this phase, Smart Villages began to function as a transitional bridge to Digital Villages. Implementation was no longer limited to the development of physical infrastructure and connectivity, but began to adopt digital technology to support decision-making, village economic efficiency, and sustainable resource management. Findings showed that sustainable development played a central role in connecting technology, governance, and regional development, indicating that village digitalization was beginning to be

understood as a long-term goal, rather than merely technological modernization.

Period 2021-2023 marks the consolidation phase of Digital Village, where policy and research orientation shifts from digital services, data integration, and cost effectiveness. The dominance of data communication systems, cost effectiveness, and smart cities shows that Digital Village does not stand alone but is integrated into regional and national ecosystems. Villages are beginning to be positioned as producers and users of data, not just as objects of policy. This transformation also shows a shift in the role of the government from a technology provider to an enabler of a digital ecosystem that involves the private sector, local communities, and other non-governmental actors.

In addition, the emergence of tourism development and cultural identity indicates that Digital Village in Indonesia is beginning to adopt a place-based and inclusive approach, where technology is used to strengthen local identity, the creative economy, and sustainable tourism. This distinguishes Digital Villages from early-generation Smart Villages, which tended to mimic urban models. Digital Villages emphasize the contextualization of technology in accordance with the social, cultural, and economic characteristics of villages.

In the latest phase (2024-2025), the direction of Digital Village implementation further emphasizes the integration of sustainability, multilevel governance, and the digital ecosystem. Clusters related to legal effectiveness, smart regions, and village SDGs show that digital villages are no longer understood as projects, but as part of regional development strategies and the achievement of sustainable development goals. At this stage, Digital Village serves as a strategic hub that connects national policies, technological innovations, and local needs.

In conceptual terms, this finding enriches the literature by showing that the main difference between Smart Villages and Digital Villages lies in the orientation of implementation. Smart Villages place greater emphasis on initial readiness, starting with regulations, infrastructure, and basic governance, while Digital Villages focus on optimizing the use of technology through data, digital services, and ecosystem collaboration. Thus, Digital Village is not a substitute for Smart Village, but rather a logical evolution that emerges once the basic prerequisites have been met.

The policy implications of these findings are quite significant. First, a one-size-fits-all approach to digital village implementation has the potential to be ineffective, given the differences in the readiness of

villages. Second, the success of Digital Village is highly dependent on the integration of cross-sectoral and cross-level government policies. Third, strengthening human resource capacity and data governance are key to ensuring the sustainability of village digital transformation. Digital transformation is not only for sectoral needs but also for global needs that will emerge in the future (Trendov et al., 2019; World Bank, 2017, 2019).

Some people view digital transformation as a solution to the challenges faced by the agricultural sector and rural areas (Trendov et al., 2019; World Bank, 2019), but some still believe that moving towards 'Agriculture 4.0' (Klerkx and Rose, 2020) will impact the transformation of agrifood systems (Herrero et al., 2021; Klerkx and Begemann, 2020). However, lessons learned from previous technological revolutions indicate the need for caution (Bronson, 2019; Eastwood et al., 2019).

Overall, this study confirms that the transformation of villages in Indonesia during 2016-2025 is an evolutionary process influenced by the interaction between policy, technology, and local context. By systematically mapping research and implementation phases, this study provides a conceptual framework that can be used as a basis for formulating more adaptive, sustainable, and long-term impact-oriented digital village policies (Dufva and Dufva, 2018; Fielke et al., 2021; Rijswijk et al., 2019).

Currently, digital technology may have several unintended, hidden, and unknown impacts (Klerkx and Rose, 2020; Pansera et al., 2019; Scholz et al., 2018). For example, it has been argued that rather than transforming agriculture and rural areas, digital technology actually reinforces outdated systems (Clapp and Ruder, 2020; Cowie et al., 2020; Miles, 2019; Prause et al., 2020).

Current digital technologies may have some unintended, hidden, and unknown impacts, such as emergent effects that only become apparent after the technology is implemented in practice (Klerkx and Rose, 2020; Pansera et al., 2019; Scholz et al., 2018). For example, it has been argued that rather than transforming agriculture and rural areas, digital technology reinforces the current system, which is considered unsustainable economically, socially, and ecologically, and benefits existing large players (Clapp and Ruder, 2020; Cowie et al., 2020; Miles, 2019; Prause et al., 2020).

However, digital technology is likely to have unintended consequences in practice (Klerkx and Rose, 2020; Pansera et al., 2019; Scholz et al., 2018). It may even reinforce unsustainable digital technology in society (Clapp and Ruder, 2020; Cowie et al., 2020; Miles, 2019; Prause et al., 2020).

Conceptual Evolution

Bibliometric results with the keyword search “Smart Village” AND “Digital Village” amounted to 1332, then filtered based on the years 2016-2025, identified 5 clusters with 334 documents sourced from 131 conference papers, 130 articles, 42 book chapters, 17 conference reviews, and 4 types of books. The concept discussed is the application of a conceptual evolution model. Based on the results of the VOSviewer overlay visualization, the conceptual evolution of Smart Village and Digital Village shows a clear temporal shift from fundamental themes towards a more complex and integrated digital approach. The overlay colors indicate that 2016-2018 was dominated by basic concepts of governance and rural areas, while the terms that emerged in the more recent period (2021-2025) were increasingly concentrated on digital transformation, data management, and sustainability.

In the early period (2016-2017), nodes with darker colors indicate the dominance of terms such as rural areas, community, and local regulations. This reflects that Smart Village in its early stages was positioned as a framework for development and institutionalization to strengthen village governance and reduce regional disparities. The conceptual focus was still limited to institutional readiness and the integration of villages into the national development agenda, with technology playing a supporting role rather than a central one.

Entering 2018, the overlay visualization shows an increasingly strong link between Smart Village and the term sustainable development. The nodes in this phase occupy a transitional role, connecting the initial governance framework with the technological developments that emerged later. This shows that sustainability began to function as a connecting conceptual principle, where village digitalization began to be understood as a means of long-term development, not merely a technical innovation.

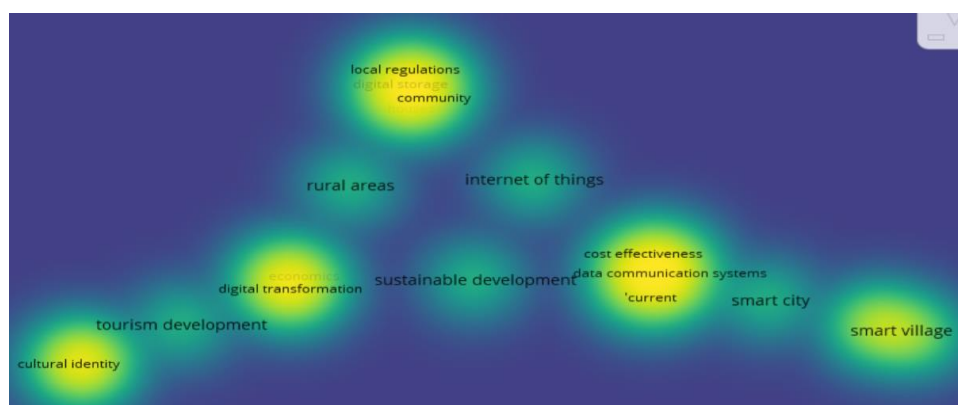


Figure 2

Sources: Digital Villages Overlay

Period 2019-2020 marked a significant conceptual shift, as indicated by the emergence of brighter colored nodes such as digital transformation, internet of things, and information systems. At this stage, Smart Village transitioned to Digital Village, with a shift in focus from governance efficiency to the formation of digital technology-based village development. Overlay visualization places these terms in an area that connects sustainability and data, confirming its role as a conceptual transition phase.

In the consolidation phase (2021-2022), the newest nodes are increasingly concentrated on the themes of data communication systems, cost effectiveness, and smart cities. The brighter overlay colors indicate that Digital Village is beginning to be understood as part of a broader ecosystem, integrated with urban and regional areas. Villages are no longer positioned as development units but as active actors in cross-regional data and digital service exchanges.

Moreover, the 2023 period shows the emergence of terms related to tourism development and cultural identity, which occupy a peripheral but strategic position in the development map. Overlay visualization in this phase indicates a shift from a technology-centric approach to contextualization of digitalization, where technology is used to strengthen local identity and village-based economies.

In the most recent phase (2024-2025), the brightest colored nodes show the dominance of terms such as legal effectiveness, smart region, and Village SDGs. This indicates that Digital Village has evolved into a conceptual framework that emphasizes multilevel governance, policy integration, and the achievement of sustainable development goals. Village digitalization at this stage is no longer understood as a technology project, but rather as a policy and innovation ecosystem oriented towards long-term impact.

In general, overlay visualization confirms that the evolution from Smart Village to Digital Village is progressive and cumulative. Smart Village dominates the initial phase as the foundation of governance and institutional readiness, while Digital Village emerges and strengthens in the subsequent phase as a paradigm of transformation based on data, digital services, and sustainability. Thus, Digital Village is not a separate concept, but rather the result of conceptual evolution that is empirically reflected in the temporal shift of 14 research studies. The conceptual evolution of Smart Village and Digital Village (2016-2025) is as follows:

- a. In 2016, Smart Village was viewed as an adaptation of Smart City. In the early stages, Smart Village was understood as an adaptation of the Smart City concept to rural areas. The conceptual focus was on the

efficiency of public services, basic connectivity, and village governance. Technology was positioned as a tool to support the modernization of village administration, with a top-down and regulation-based approach.

b. In 2017, the focus was on strengthening governance and community participation. The Smart Village concept began to emphasize the role of local communities and local governance. Digital literacy, development participation, and strengthening village institutions became important elements. Smart Villages were no longer just about infrastructure, but also social and institutional capacity.

c. In 2018, the perspective of Sustainability Integration and Regional Development. The discourse on Smart Villages is increasingly linked to sustainable rural development. This concept has begun to be associated with rural economic resilience, local resource management, and social inclusion. Sustainability has become a key development principle, although implementation still focuses on initial readiness.

d. In 2019, the initial vision of the transition to Digital Village emerged. At this stage, there was a conceptual shift from Smart Village to Digital Village. Digital technology not only supports services but also begins to shape data-driven village governance. The terms digital transformation and IoT became dominant, marking a shift from “smart” to “digital-enabled governance.”

e. In 2020, Digital Village is viewed as a socio-technical system. Digital Village is understood as an integrated socio-technical system, not merely the use of technology. The COVID-19 pandemic has accelerated the adoption of digital village services (administration, social assistance, digital economy). Data, connectivity, and online services are core elements of the concept.

f. In 2021, Consolidation of Services and Data Governance. The Digital Village concept enhances the effectiveness of services and data governance. Villages are beginning to be positioned as producers of development data. Issues of interoperability, data security, and cost efficiency are becoming an important part of the conceptual discourse.

g. In 2022, the vision of Digital Village Integration in the Regional Ecosystem. Digital Villages no longer stand independently, but are integrated with smart regions and smart cities. This concept emphasizes inter-regional connectivity, cross-sector collaboration, and the role of villages in the regional value chain. Digital Villages have become part of the regional development architecture.

- h. In 2023, the focus will be on a contextual and locally-based approach. Conceptual evolution emphasizes context-aware digitalization. Technology is utilized to strengthen cultural identity, village tourism, and the local creative economy. Digital Village is understood as a platform for empowerment, not technological homogenization.
- i. In 2024, the vision for Digital Villages will be based on sustainability and village SDGs. Digital Villages will be explicitly linked to village SDGs. This concept positions digital technology as a means of achieving social, economic, and environmental goals. Multilevel governance and legal effectiveness will be key conceptual issues.
- j. In 2025, the Digital Village is viewed as a Village Innovation Ecosystem. At its most advanced stage, the Digital Village is understood as an innovation ecosystem based on data, collaboration, and long-term sustainability. The focus shifts from technology adoption to resilience, local innovation, and policy impact. The Smart Village serves as the historical foundation, while the Digital Village becomes the dominant paradigm of village development.

In general, this evolution shows a shift from:

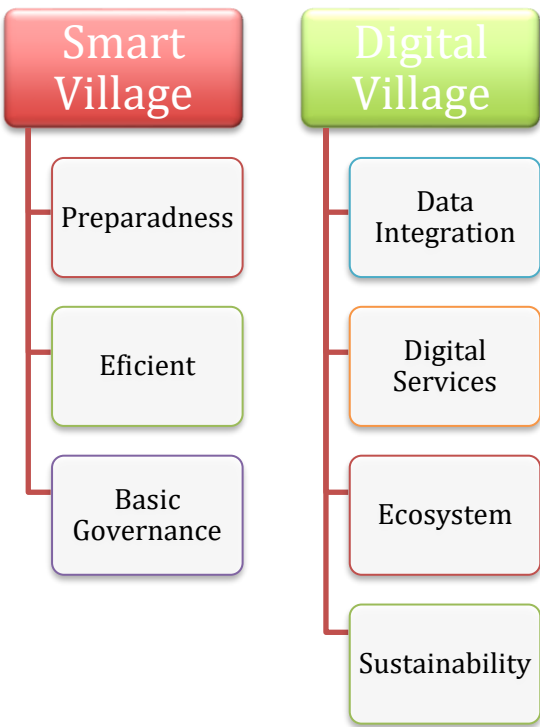


Figure 3

As per the references that have been developed earlier, The concepts of Smart Village and Digital Village have evolved substantially over the past decade. Although the two terms are often used interchangeably in policy documents, recent academic literature increasingly distinguishes

them based on their conceptual orientation, scope, and developmental objectives.

Initially, the Smart Village concept emerged as an adaptation of the Smart City paradigm, emphasizing the application of information and communication technologies (ICT) to address rural challenges such as limited infrastructure, restricted access to public services, and economic disparities. Early studies viewed Smart Villages primarily as technology-enabled rural communities where broadband connectivity, digital infrastructure, and e-government services were expected to improve public service delivery and rural competitiveness. However, subsequent research argues that Smart Village should not be reduced to technological advancement alone. Instead, it represents an integrated rural development approach that combines digital innovation with social inclusion, local governance, economic diversification, environmental sustainability, and community participation (Klerkx & Rose, 2020; Cowie et al., 2020). Consequently, Smart Village has gradually shifted from a technology-centric concept toward a holistic rural development paradigm in which digital technology functions as an enabler rather than the ultimate objective.

In contrast, the Digital Village concept has developed from a more operational perspective. Rather than representing an ideal development outcome, Digital Village refers to the process through which villages adopt digital technologies across governance, public administration, public services, economic activities, and community interactions. Digital Village emphasizes digital transformation by integrating digital infrastructure, information systems, digital literacy, institutional capacity, and community participation into village development processes (Trendov et al., 2019; Klerkx & Rose, 2020). This transformation extends beyond the digitization of administrative procedures, encompassing data-driven governance, digital public services, digital entrepreneurship, and rural innovation ecosystems (Wolfert et al., 2014).

The conceptual evolution between the two terms demonstrates an important paradigm shift. Earlier literature tended to regard Digital Village as merely one component of Smart Village implementation. More recent studies, however, position Digital Village as the foundational stage of rural digital transformation, while Smart Village represents the maturity stage in which digital technologies are effectively embedded within broader governance, economic, social, and environmental systems. In other words, Digital Village focuses on building digital readiness and institutional transformation, whereas Smart Village reflects the

sustainable outcomes generated through that transformation (Klerkx & Rose, 2020; Trendov et al., 2019).

Accordingly, this study conceptualizes Digital Village as the process of digital transformation that strengthens village governance, public services, community capacity, and digital connectivity. Smart Village, meanwhile, is understood as the higher-order developmental condition achieved when digital transformation successfully supports sustainable, inclusive, participatory, and resilient rural development. Under this perspective, the two concepts are not contradictory but complementary, with Digital Village serving as the foundation upon which Smart Village can be realized.

RESEARCH CLUSTERS

According to the bibliometric results with 5 clusters from 2016 to 2025, there are several aspects, which are:

Table 2. Synergy between Smart Villages and Digital Villages based on Clustering

Aspect	Smart Village	Digital Village
Access to information and the Internet	Focus on reducing the gap	Focus on connectivity & usage
Public welfare	Improving quality of life	Expanding digital benefits to social services
Digital economic	Developing the local digital economy	Enhancing online economic capabilities
Digital Government	Improving village government services	Digitalization of administration & public services
Digital literacy	needs improvement	Main components of the program

Sources: References from Various Sources

Clustering will provide clarity on the status of smart villages and digital villages, especially in the context of annual development paradigms that experience friction or shifts in concepts and policy implementation.

Table 3. Clustering Based on Bibliometrics

Cluster	Keywords	Meaning	Dominance
Cluster 1 : Environmental & Infrastructure Management (21 items)	cost effectiveness data communication systems information management solid waste management environmental management waste collection, waste disposal	This cluster represents the technocratic approach of Smart Village, where technology is used for: efficiency, environmental management, infrastructure optimization.	Early-mid phase of Smart Village ($\pm$ 2016–2019)
Cluster 2: Community, IoT & Local Governance (19 items)	community internet of things (IoT) local regulations	The link between the main bridge of Smart	Transition phase (2018–2021)

	participatory design sensor networks management framework land ownership, laws and legislation	Village to Digital Village: technology (IoT) is linked to the community local regulatory issues & participation arise villages begin to be positioned as actors, not objects.	The beginning of context-based Digital Villages
Cluster 3: Digital Transformation & Rural Development (15 items)	digital transformation rural development rural areas economics government data processing sustainable development smart village index	connecting technology, economy, and villages conceptually and policy- wise strong often serves as a hub in network visualization	Transition & Consolidation Paper for Digital Village (2019–2023) Becoming the foundation for national policy narratives
Cluster 4: Cultural Identity & Sustainable Rural Tourism (12 items)	cultural identity sustainable rural tourism tourism development technology acceptance user perception inclusive design	Digital Village is not culturally neutral. Technology is studied from the perspective of development acceptance. Rural tourism is the main use case.	Digital Village maturation phase (2021–2024) Shift from efficiency → meaning & identity
Cluster 5: Smart City–Smart Village–SDGs Nexus (10 items)	smart village smart city smart region village SDGs urban planning strategies socio-economic disparity	This cluster is strategic in nature: discusses village-city relations, Smart Village is positioned within the framework of sustainable development (SDGs), often appears in policy papers.	Initial phase & reflective phase (2016– 2018, then 2023–2025) Smart Village as a conceptual framework, not a primary practice

Sources: Compiled from various sources

Development Analysis identified five key studies, which showed a clear shift from technology-driven Smart Village studies to a more integrated Digital Village paradigm, emphasizing digital transformation, development participation, cultural identity, and sustainable rural development.

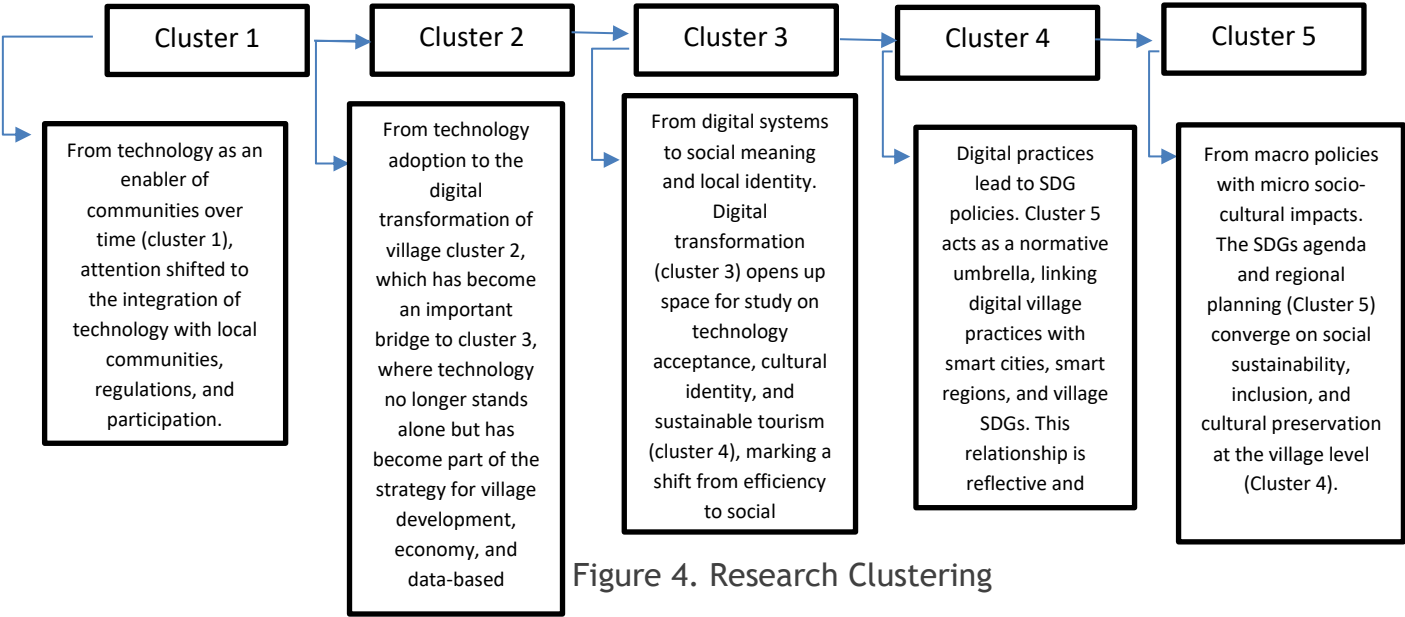


Figure 4. Research Clustering

Policy Implication

Based on bibliometric findings, several strategic implications were identified:

- a. Governance Reform: The government must shift from a technology procurement model to a digital governance ecosystem, prioritizing service integration, interoperability, and citizen-focused design. The needs of citizens are important, taking into account the opportunities and strengths of the village. Creating a digital village will provide space for citizens to develop quality and receive quality services based on global adjustments and institutional value enhancement and changes in public services (Cao, Niu, & Wang, 2022).
- b. Capacity building, digital literacy, administrative capabilities, and community involvement must be the main pillars of the Digital Village policy.
- c. Integrated Policy Framework: Policies must integrate infrastructure, governance, social empowerment, and sustainability, rather than implementing fragmented ICT projects.
- d. Evidence-Based Policy, Bibliometric insights should guide: Funding priorities for research investment and innovation dissemination strategies.

REFERENCES

1. Bai, Changyi, Wen Guan, Dawei Wang, International Review of Economics and Finance. (2024). Digital village construction and the quality of life of rural

- residents, *International Review of Economics and Finance* 96 (2024) 103729, p 1-13, <https://doi.org/10.1016/j.iref.2024.103729>
2. Barro, R. J. (2002). Quantity and quality of economic growth. Working Papers Central Bank of Chile, 5(2), 17-36.
 3. Barrett, H., Rose, D.C., (2020). Perceptions of the fourth agricultural revolution: what's in, what's out, and what consequences are anticipated? *Sociol. Rural.* <https://doi.org/10.1111/soru.12324>. In press.
 4. Bronson, K., (2019b). Looking through a responsible innovation lens at uneven engagements with digital farming. *NJAS - Wageningen J. Life Sci.* 90-91, 100294 <https://doi.org/10.1016/j.njas.2019.03.001>
 5. Cao, L., Niu, H., & Wang, Y. (2022). Utility analysis of digital villages to empower balanced urban-rural development based on the three-stage, DEA-Malmquist model. *PLoS One*, 17(8).
 6. Clapp, J., Ruder, S.-L., (2020). Precision technologies for agriculture: digital farming, gene-edited crops, and the politics of sustainability. *Global Environ. Polit.* 20 (3), 49-69. https://doi.org/10.1162/glep_a_00566.
 7. Cowie, P., Townsend, L., Salemink, K., (2020). Smart rural futures: will rural areas be left behind in the 4th industrial revolution? *J. Rural Stud.* 79, 169-176. <https://doi.org/10.1016/j.jrurstud.2020.08.042>.
 8. Clapp, J., Ruder, S.-L., (2020). Precision technologies for agriculture: digital farming, gene-edited crops, and the politics of sustainability. *Global Environ. Polit.* 20 (3), 49-69. https://doi.org/10.1162/glep_a_00566.
 9. Cowie, P., Townsend, L., Salemink, K., (2020). Smart rural futures: will rural areas be left behind in the 4th industrial revolution? *J. Rural Stud.* 79, 169-176. <https://doi.org/10.1016/j.jrurstud.2020.08.042>
 10. Dufva, T., Dufva, M., (2018). Grasping the Future of the Digital Society. *Futures.* <https://doi.org/10.1016/j.futures.2018.11.001>.
 11. Eastwood, C., Klerkx, L., Ayre, M., Dela Rue, B., (2019b). Managing socio-ethical challenges in the development of smart farming: from a fragmented to a comprehensive approach for responsible research and innovation. *J. Agric. Environ. Ethics* 741-768.
 12. Fielke, S.J., Taylor, B.M., Jakku, E., Mooij, M., Stitzlein, C., Fleming, A., Vilas, M.P., (2021). Grasping at digitalisation: turning imagination into fact in the sugarcane farming community. *Sustainability Science* 16, 677-690. <https://doi.org/10.1007/s11625-020-00885-9>.
 13. Gil-Lacruz, M., Gil-Lacruz, A. I., Domingo-Torrecilla, P., & Cañete-Lairla, M. A. (2021). Health-related quality of life and physical activity in a community setting. *International Journal of Environmental Research and Public Health*, 18(14), 7301.
 14. Herrero, M., Thornton, P.K., Mason-D'Croz, D., Palmer, J., Bodirsky, B.L., Pradhan, P., Barrett, C.B., Benton, T.G., Hall, A., Pikaar, I., Bogard, J.R., Bonnett, G.D., Bryan, B. A., Campbell, B.M., Christensen, S., Clark, M., Fanzo, J., Godde, C.M., Jarvis, A., Loboguerrero, A.M., Mathys, A., McIntyre, C.L., Naylor, R.L., Nelson, R., Obersteiner, M., Parodi, A., Popp, A., Ricketts, K., Smith, P., Valin, H., Vermeulen, S. J., Vervoort, J., van Wijk, M., van Zanten, H.H.E., West, P.C., Wood, S.A., Rockström, J., (2021). Articulating the effect

- of food systems innovation on the Sustainable Development Goals. *The Lancet Planetary Health* 5, e50-e62.
15. Klerkx, L., Rose, D., (2020). Dealing with the game-changing technologies of Agriculture 4.0: how do we manage diversity and responsibility in food system transition pathways? *Global*
 16. Lajoie-O'Malley, A., Bronson, K., van der Burg, S., Klerkx, L., (2020). The future(s) of digital agriculture and sustainable food systems: an analysis of high-level policy documents. *Ecosystem Services* 45, 101183. <https://doi.org/10.1016/j.ecoser.2020.101183>.
 17. Li, G. Y., Liu, Z. H., Liu, T. S., & Chen, L. (2024a). Twisted industrial structure, land financing mode and social security. *Finance Research Letters*, 69, Article 106115.
 18. Liu, Y. Y., Wan, Q., & Chen, W. (2023). Digital inclusive finance as a catalyst for rural revitalization: An empirical analysis from the county development perspective in Hubei Province. *J Knowl Econ*.
 19. Ma, H. X., Yin, Y. K., Liu, Z. H., & Yi, B. (2024). A study of the impact of digital finance usage on household consumption upgrading: Based on financial asset allocation perspective. *International Review of Economics & Finance*, 96, Article 103628.
 20. Miles, C., (2019). The combine will tell the truth: on precision agriculture and algorithmic rationality. *Big Data & Society*. <https://doi.org/10.1177/2053951719849444>. In press
 21. Owen, R., Macnaghten, P., Stilgoe, J., (2012). Responsible research and innovation: from science in society to science for society, with society. *Sci. Publ. Pol.* 39 (6), 751-760.
 22. Pansera, M., Ehlers, M.-H., Kerschner, C., (2019). Unlocking wise digital techno-futures: contributions from the Degrowth community. *Futures* 114, 102474.
 23. Prause, L., Hackfort, S., Lindgren, M., (2020). Digitalization and the third food regime. *Agric. Hum. Val.* <https://doi.org/10.1007/s10460-020-10161-2>. In press
 24. Rijswijk, K., Klerkx, L., Turner, J.A., (2019). Digitalisation in the New Zealand Agricultural Knowledge and Innovation System: initial understandings and emerging organisational responses to digital agriculture. *NJAS - Wageningen J. Life Sci.* 90-91, 100313 <https://doi.org/10.1016/j.njas.2019.100313>.
 25. Rose, D.C., Chilvers, J., (2018). Agriculture 4.0: broadening responsible innovation in an era of smart farming. *Frontiers in Sustainable Food Systems* 2 (87). <https://doi.org/10.3389/fsufs.2018.00087>
 26. Pereira, G., (2018). Unintended side effects of the digital transition: European scientists' messages from a proposition-based expert round table. *Sustainability* 10 (6), 2001. <https://doi.org/10.3390/su10062001>
 27. Trendov, N.M., Varas, S., Zeng, M.,(2019). Digital Technologies in Agriculture and Rural Areas - Status Report. Rome. <http://www.fao.org/3/ca4985en/ca4985en.pdf>.

28. World Bank, (2019). Future of Food Harnessing Digital Technologies to Improve Food System Outcomes. Washington, DC. <https://openknowledge.worldbank.org/handle/10986/31565>.
29. Wolfert, S., Goense, D., Sørensen, C.A.G., (2014). A Future Internet Collaboration Platform for Safe and Healthy Food from Farm to Fork. Paper Presented at the 2014 Annual SRII Global Conference.