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ORIGINAL ARTICLE

SMART VILLAGE BASED ON AGRICULTURE BIG DATA ANALYTIC: REVIEW AND FUTURE RESEARCH AGENDA

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Abstract: Smart villages have become a concern for governments, private sectors and Non-Governmental Organizations (NGOs) in various countries as a solution in overcoming poverty. This research is focus on strengthening the Information and Communication Technology (ICT) level, especially the concept of agriculture big data analytic (ABDA)- based smart villages. Systematic Literature Review (SLR) of ABDA-based smart villages is carried out through descriptive analysis (single and cross attributes as well as a hierarchy of attributes and research domains) and cluster analysis (word frequency analysis) using NVivo 12 Plus software. SLR is not only carried out on smart village papers but including the cluster analysis integrated with documents related to citizen science. Most of the previous authors applied model or concept construction method, but there is lack of implementation and comprehensive analysis of the smart village system. The previous articles were dominated by automation and big data analytic (BDA) for Climate Smart Agriculture (CSA), but lack of application about ABDA post-harvest activities. The contribution of this research showed the confirmation of the structure of the smart village success variables (technology, community, resources, and services/sustainability) and seven future research agendas of smart village based on ABDA. The seven smart village future research agendas are : Decision Support System-Geographic Information System (DSS- GIS) based smart governance; ABDA-based smart economy; BDA-based smart mobility; BDA-based smart environment; smart people based on non-formal e-learning education, simulation, Augmented Reality (AR), Virtual Reality (VR) and Mix Reality (MR); DSS-GIS-IoT based smart living and DSS-GIS-based smart tourism.

***Key words*:** Agriculture big data analytic, Citizen science, DSS, GIS, Smart village, Systematic Literature review.

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1. Introduction

One of the goals of the Indonesian government's third Nawacita program is to develop Indonesia from the periphery by strengthening regions and villages within the framework of a unitary state. Achieving the objectives of this program faces many challenges because of the imbalance of available resources in rural areas. Decreasing agricultural land, along with the decreasing population of productive age in rural areas, is very influential on the decline in agricultural productivity in Indonesia. One example in West Java Province, 72.9% of the population lives in cities. The Central Statistics Agency (BPS) (2018) projects that in 2035, the population living in urban areas will increase to 89.3%. Cities are more attractive to live in because they provide more jobs and business opportunities. If this condition is not immediately resolved, rural areas will be increasing abandoned, so poverty will increase (13.2% in rural areas and 7.38% in urban areas) [Central Statistics Agency (2021)] and the Nawacita goal will be difficult to achieve poverty in farmers is a major issue that the government wants to resolve

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through this Nawacita program.

The issue of urban and rural inequality is increasing with the development of ideas, concepts and implementation of smart cities. Smart cities were developed because of the rolling of the implementation of the Industrial Revolution 4.0 which provided various advantages in the management of people's lives, especially in overcoming various problems. Smart cities are defined as cities that optimize Information and Communication Technology (ICT) to improve the quality of life of citizens through sustainable development [Ramaprasad *et al*. (2017), Nam and Pardo (2011)]. One way to reduce urban and rural inequality is proposed ideas and concepts of smart villages [Anderson *et al*. (2017), European Network for Rural Development (2018)]. The proposed method is descriptive analysis (single and cross-attribute and attribute and research hierarchies domain) and cluster analysis (word frequency analysis) using the NVivo 12 Plus software, and this method is the most important advantage of our work.

The concept of smart villages was developed along with the rampant process of smart city development, which had previously been widely conceived, researched, and even implemented in many countries [Afnarius *et al*. (2020), Holmes (2017)]. The principle of smart cities and smart villages is directed towards the achievement of Sustainability Development Goals (SDGs) [Natarajan and Kumar (2017), Pham *et al*. (2016), Malche and Maheshwary (2017)]. Smart village development as an effort to reduce poverty and narrow the gap in rural and urban development is one of the solutions carried out by various countries. Therefore, a review and preparation of a future research agenda for smart villages still need to be done, which is focused on strengthening the ICT level especially the concept of agriculture big data analytic.

The purpose of this study is to review and survey smart village research conducted through SLRs, using descriptive and cluster analysis, through the help of the NVivo 12 Plus software. The expected results are a confirmation of the success variables of the smart village and a map of future research for the smart village.

The main contributions of this paper are:

a. Systematic literature review using cross-attribute and clustering techniques that produce a dendrogram of keywords for smart village development based on agriculture big data analytics.
b. Gaps, road maps and future research mapping for smart village development based on agriculture big data analytics.

2. Smart Village Terminology

2.1 Smart Village Definition

Smart village is a development of citizens, who take the initiative and collaborate with institutions, such as private sectors, community organizations and governments to find solutions to existing problems and to transform the village into more productive and independent [Anderson *et al*. (2017), European Network for Rural Development (2018)]. Research on smart villages experienced significant growth and one of the supporting factors was the development of very massive ICTs, even in rural areas [Afnarius *et al*. (2020), Holmes (2017)]. Smart village is a laboratory where villagers and policymakers from various levels test innovative solutions to the challenges of rural life. Smart villages in the European Union are based on five reasons: responding to depopulation and demographic changes, seeking local solutions through public funding and centralizing public services, explaining the relationship between villages and cities, maximizing the role of rural areas in the transition to low-carbon and circular economic concepts and promotion of digital transformation in rural areas.

2.2 Development of Smart Villages in Several Countries

In general, the conceptual model of smart villages can be distinguished through variables of objectives, strategies, dimensions, and foundation of development [Sealy (2003)]. The development of smart villages is greatly influenced by the resource conditions and potential of each village. Therefore, the ideal concept of a smart village will be unique and have different characteristics depending on political, economic, social, and cultural conditions.

The development of smart villages in the European Union is based on five reasons: 1) responding to depopulation and demographic changes, 2) finding local solutions through public funding and centralizing public services, 3) exploring the relationship between villages and cities, 4) maximizing the role of rural areas in the

transition to low carbon concepts, and 5) economic circulation and the promotion of digital transformation in rural areas.

The development of smart villages in India is based on the vision of Mahatma Gandhi, that the ideal village to build an independent state depends on its proximity to daily vital needs. The smart village framework in India is self-reliant manpower through appropriate rural technologies. This framework is supported by 3 foundations namely: 1) Self-reliant covering food, water, and energy for villagers, livestock and agriculture, which is raised from local resources or supplied, 2) Empowerment of village human resources focus on village youth who must get proper education and work, and adequate nutrition, and 3) Senior villagers are provided with recreation centers, hospitals, and nursing homes. Appropriate village technology in the form of sustainable technology aims to develop agriculture, animal husbandry, and irrigation management. Spatial-based technology for diverse land uses is packaged in a communicative and user-friendly user interface [Ramachandra *et al*. (2015)].

Smart villages in six regions (West and East Africa, North and North East Asia, North and Central America, the Caribbean and Mexico) were developed and funded by the Cambridge Malaysian Education and Development Trust (CMEDT), in collaboration with the Malaysian Commonwealth Studies Center (MCSC) and supported by grants from the Templeton World Charity Foundation (TWCF). The concept of smart villages focuses on sustainable energy services, which have a catalytic influence on integrated village development through ICT. Reflections on this program are integrated to achieve several parameters of SDGs [Holmes (2017)]. Sustainable energy services (Solar Home System/SHS and Pico-solar Light) aim to provide assistance to improve environmental quality and opportunities for sustainable livelihoods, health services, education, water supply and sanitation and empowerment of villagers within the scope of the smart village concept. This smart village project was reviewed and implemented for three years (2014-2017), through various activities that included workshops, capacity building in collaboration with literature review activities, impact studies, competitions, webinars, media and follow-up workshops. The parties involved in this project include frontline workers (community villagers, entrepreneurs, Non- Government Organizations (NGOs), social organizations), policymakers and regulators, financial institutions, as well as experts in the fields of science, technology and humanities [Holmes (2017)].

The pattern of developing smart villages through electrification education and sustainable entrepreneurship has been carried out by the IEEE Smart Village team since 2010 in Africa, India and the North Pacific region. This activity can be a catalyst for socio-economic development and technological development in rural areas through community empowerment. The ultimate goal of this activity is the achievement of SDGs parameters related to poverty alleviation, water supply, sanitation, access to education, health services through ICT [Manami *et al*. (2018), Anderson (2019), Larsen and Estes (2019)].

2.3 Development of Smart Village in Indonesia

Smart village research in Indonesia has been carried out by Ella and Andari (2018), who propose a smart village model in Indonesia based on five dimensions namely resources, technology, service chains, institutions and sustainability. Distinguishing in the development of smart villages, smart cities and smart areas in Indonesia can be assessed from the following parameters: 1) community integrity, 2) history and culture, 3) spatial context in the perspective of urban and regional planning, 4) economic sector, 5) technological readiness (synergy of physical infrastructure and development facilities, substitution effects, generational effects and scale-up effects), 6) technical and political processes and 7) stakeholders [Sutriadi (2018)]. The implementation of ICT for smart village initiation includes information management in Rancasalak Garut Village [Salim (2013)], a geographic information system (GIS) based on the potential map in Cinunuk Village [Marlintha *et al*. (2017)] and Kenanga Jaya Regency [Adi and Heripracoyo (2018), Adi and Suhartono (2017)] and also in Koto Gadang West Sumatera [Afnarius *et al*. (2020)].

The review on developing smart villages in Indonesia is based on six foundations of smart cities, namely: smart people, smart living, smart environment, smart mobility, smart governance and smart economy. Comprehensive analysis of the development of four smart villages in Yogyakarta, apparently has different characteristics, according to the potential of each village. These characteristics represent cases of the smart

economy, smart governance, smart living and smart tourism [Santoso *et al*. (2019)].

The use of ICTs in the four smart villages has a different level of leveling. Kulonprogo's smart economy is based on the belabeliku.com marketplace optimization for the expansion and strengthening of the local economy of various micro, small, and medium enterprises (MSMEs) in Kulonprogo, Yogyakarta. The role of the Kulonprogo regional government has consistently appealed to its citizens to buy local products and market place optimization belabeliku.com can create economic sovereignty. The smart governance in Dlingo Village focuses on optimizing public and social services through the Village Information System (SID) and social media, to improve the community's economy, social, and democratization of society. The smart living village of Cyber Village in Patehan Urban Village, Yogyakarta City can educate residents through ICT in controlling their environment through Closed Circuit Television (CCTV). Pulepayung smart tourism was developed through website optimization, social media (Facebook and Instagram), E-Word of Mouth (Pulepayung: 16228), Travel-blog (Tripadvisor) and Travel vlogger, to improve the local economy through tourism management [Santoso *et al*. (2019)].

3. Methodology

The review process related to smart villages based on Agriculture Big Data Analytic (ABDA) is carried out through a Systematic Literature Review (SLR) approach. A literature review is basic in the research phase because the literature will form a strong foundation for the next research process. Some of the objectives of the literature review are to examine what has been done and future research potential, provide key variables, identify conceptual correlations and their implementation show the structure of research substance, survey methodologies through approaches, techniques and even algorithms used, and state-of-the-art developments [Saldana (2013)]. The complete stages are shown in Fig. 1.

The SLR method is used in this study as a guideline for conducting a systematic review. Systematic reviews can be used to look at previous concepts about the topic being studied. Furthermore, SLR can be examined the linkages between existing concepts and develop a research agenda in the future. The review process through the SLR approach was carried out with the NVIVO 12 Plus software [Hutchison *et al*. (2010)]. This software provides a systematic, measurable and projected process for smart village terminology based on ABDA that can be built using a descriptive approach and cluster analysis. The SLR method is a method of research synthesis consisting of methods: vote-counting, combining probabilities and combining magnitudes of effects [Gurevitch *et al*. (2018)]. This paper only uses the vote-counting method. The weakness of this method is not able to show the magnitude of the effect of the conceptual model of the smart village. Therefore, a systematic literature review is integrated with the text mining approach through cluster analysis which is expected to produce magnitudes of effects from the literature being studied.

This study raises research questions about the components that exist in ABDA-based smart villages. These components are divided into items such as year of publication, SDGs area, methods, and technology. The details of the research stages are as follows:

- Data collection begins with the identification of the

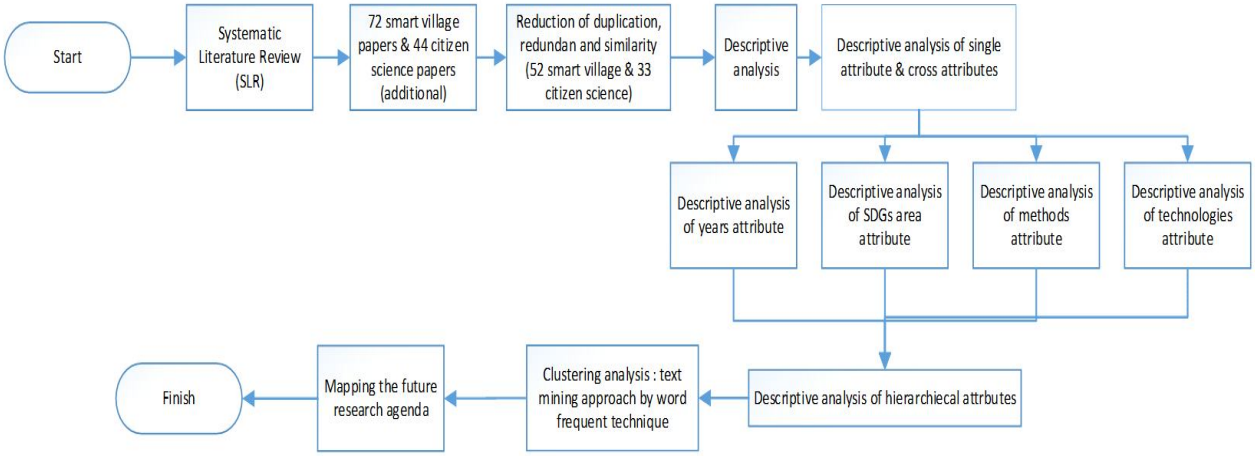

Fig. 1: Stages of Research Review

main articles related to smart villages, and additional articles related to citizen science. The articles used are only electronic articles from Mendeley's database. Keyword search articles are a smart village, smart rural, smart society, citizen science, crowdsourcing. Selected articles were published from 2013 to 2020, and there was an additional one article in 2009 as an initiation of a smart village in India. There are 61 smart village articles. The election in 2009 because it was based on the transition process from the 3.0 Industrial Revolution to 4.0 Industrial Revolution, and the role of 4.0 Industrial Revolution in early 2000 and this brought a big influence in the emergence of ideas, concepts and implementation of smart cities which in the end ten years later also emerged ideas, smart village concepts and models.

- The next step is screening, by checking article duplication. The screening results identified 12 duplications in the smart village article group, and 10 duplications in the citizen science article. The rest of the articles processed further are 57 smart village articles.
- The first feasibility test is done subjectively to see the suitability of the type of article. The article in question is published in books, journals, certain conference proceedings, or scientific magazines. The results of the first feasibility test produced 55 smart village articles.
- The second feasibility test was conducted by testing the relevance of the article with the purpose of this study. Therefore, scanning of the remaining articles was carried out and the results of the scanning produced 52 relevant articles related to ABDA-based smart villages.

The final step is that SLR uses NVivo 12 Plus for 44 smart village main articles that are appropriate and relevant to the objectives of the study. SLR is carried out with two approaches namely: descriptive and cluster analysis. Descriptive analysis is done through a single and cross attributes analysis and attribute hierarchy analysis and at this stage only involves 52 main articles of the smart village.

4. Results and Discussion

4.1 Descriptive Analysis (Single Attribute Analysis)

The results of the study of smart village research on 52 papers are presented in detail in Table 1. The percentage of smart village research distribution based on the year of publication is shown in Fig. 1. In Figs. 2 to 4, also the details of the distribution of smart village papers are based on the type of research method, SDGs area, and technology used. Research related to the development of smart villages in other countries has been developing since 2009 [Misra (2009)], with a project with a minimum term of three years [Anderson *et al*. (2017)]. Many of the results of this research were reported and published in 2013. Therefore, the reviewed literature is in the 2013-2020 range. In Indonesia research on smart villages has only been developing since 2017 and is still dominated by literature review/ survey research, analysis, modeling or only focus on developing Management Information Systems (MIS) or Geographic Information Systems (GIS) without being discussed in a comprehensive collaborative manner with citizen science and concepts Big Data Analytic.

From Table 1, we have defined a = Review; b = Construction, implementation & analysis; c = Model analysis; d = System construction; e = Syst. Constr. & analysis; f = Energy; g = Water, sanitation & environment; h = Health; i = Entrepreneur; j = Education; k = Agriculture; l = Tourism; m = Poverty & welfare; n = Gender; o = General; p = MIS/GIS; q = Hardware System; r = DSS; s = Big Data Analytic; t = Climate Smart Agriculture (CSA) / Embedded; u = Sentiment Analysis; v = AR, VR & multimedia; w = Ubiquitous.

Based on best practices the implementation of smart villages in several countries shows that smart villages require optimization of the collaboration of four-partite entities (Academic - Business - Community - Government) [Tosida *et al*. (2020a)]. This is then used as a basis for the initial review and proposal of the concept of smart villages. Academic entities are represented by universities that have established Research and Community Service Frameworks (PPM) and carry out vision-mission and generally cover the fields of human resource empowerment and institutional strengthening, research, and dissemination of science and technology and system and business innovation. Smart village research can be categorized as part of a sub-model of the Smart Agro system 4.0 Model specifically in the Automated Agro system domain, the Smart Rural sub-domain. The strength of academics plays an important role in the successful implementation

Table 1: Detailed Results of the Review in the Smart Village Literature.

No.	Papers	Method				SDGs Area										ICT Area									
		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	
1.	Afnarius *et al*. (2020)					•							•				•								
2.	Anderson (2019)					•	•				•	•		•			•	•							
3.	Vinuesa *et al*. (2020)			•												•			•	•					
4.	Jagustović *et al*. (2019)			•			•	•			•	•				•					•				
5.	Larsen and Estes (2019)		•				•	•				•		•				•							
6.	Santoso *et al*. (2019)		•					•			•		•				•								
7.	Assumpcao *et al*. (2019)		•					•												•	•				
8.	Groot *et al*. (2019)			•						•		•								•	•				
9.	Adi and Heripracoyo (2018)				•								•			•	•								
10.	Ella and Andari (2018)			•				•	•		•	•					•								
11.	ENRD(2018)		•						•	•	•	•					•								
12.	Mital and Hariharan (2018)			•								•									•				
13.	Mishbah *et al*. (2018)	•							•	•	•	•	•			•	•								
14.	Zavratnik *et al*. (2018)	•						•	•			•	•			•									
15.	Huang *et al*. (2018)			•					•	•									•	•					
16.	Krishan and Suhag (2019)						•				•								•						
17.	Shen and Wang (2018)			•						•			•				•		•	•					
18.	Manami *et al*. (2018)			•				•				•						•							•
19.	Sutriadi (2018)			•												•									
20.	Thornton *et al*. (2018)			•								•									•				
21.	Visvizi and Lytras (2018)	•					•	•	•	•	•	•								•					
22.	Lin *et al*. (2018)					•		•			•		•				•	•					•		
23.	Mishra *et al*. (2018)			•			•	•			•	•								•		•			
24.	Adi *et al*. (2017)				•								•				•								
25.	Anderson *et al*. (2017)					•	•	•				•		•				•							
26.	Holmes (2017)		•				•	•	•	•	•	•		•	•		•	•								
27.	Marlintha *et al*. (2017)					•										•	•								
28.	Garai *et al*. (2017)					•	•												•						
29.	Shafrizaedh *et al*. (2017)					•	•											•							
30.	Malche *et al*. (2017)						•	•				•								•					

Table 1 continued...

Table 1 continued...

31.	Santhiyakumai *et al*. (2016)		•									•	•				•		•					
32.	Safdar and Heap (2016)		•				•	•				•		•			•	•						
33.	Gao *et al*. (2016)			•				•									•							
34.	Limaye *et al*. (2016)			•			•		•							•								
35.	Pham *et al*. (2016)		•									•						•		•				•
36.	Prinsloo *et al*. (2016)		•				•											•						
37.	Ristianti (2016)			•					•								•							
38.	Ramachandra *et al*. (2015)		•					•	•		•	•		•			•							
39.	Phahlmohlaka *et al*. (2015)			•						•	•		•			•	•							•
40.	Ranade *et al*. (2015)			•					•		•	•					•		•					
41.	Azizul *et al*. (2015)			•																•				
42.	Salim (2013)					•											•							
43.	Phahlamohlka *et al*. (2014)			•						•	•		•				•							
44.	Misra, (2009)			•									•				•							
45.	Maja *et al*. (2020)	•					•	•	•	•	•	•	•	•	•	•								
46.	Tosida et al. (2020a)			•			•			•				•		•			•					
47.	Tosida *et al*. (2020b)					•	•			•				•		•	•		•					
48.	Kuncoro *et al*. (2020)					•		•												•	•		•	
49.	Wensheng (2020)					•				•				•		•	•		•					
50.	Li *et al*. (2017)		•				•																•	
51.	Riascos *et al*. (2015)		•				•															•	•	
52.	Verma and Kumar (2016)		•				•	•														•	•	

of smart villages [Huang *et al*. (2018), Krishan and Suhag (2019)].

Business entities, in this case, are represented by private parties who can collaborate in funding, MSME product users from smart villages, or even partners in marketing, community empowerment, education, and capital assistance. This business entity also includes e-commerce parties. The develop of smart villages is very closely related to agriculture, by most demographic conditions in the village. Therefore, agricultural e-commerce can play a very significant role in strengthening smart villages [Misra (2009)].

Agricultural e-commerce in Indonesia including Tani, -Hub, IGrow and Sayur Box has contributed to collaborating with around 30.254 farmers in the capital and marketing process. This condition is an excellent opportunity in developing smart villages related to ABDA optimization, through collaboration with e-commerce parties. Collaboration e-commerce can be developed through data optimization utilizing web scraping technology. The data can be optimized as input data to build price and agricultural market prediction models, to provide accurate and fast information, and easily accessible to farmers and stakeholders.

Another business entity is the bank for collaboration in providing capital assistance. The current problem in Indonesia is that around 96.5% of farmers use capital at their own expense, and the remaining 3.5% borrow capital either with interest or without interest. Loans with interest can be sourced from banks, cooperatives, or other financial institutions. Of the number of farmers who borrowed capital, only about 2% used bank services, the rest chose to borrow non- banks. The lack of farmers who use banking services can be caused by various factors, both internal and external factors. Among them is the lack of knowledge of farmers related to lending procedures, convoluted processes, and the absence of collateral [Central Statistics Agency (2018)].

Banks generally show a lack of interest in financing the agricultural sector which is seen as high risk, both due to natural disturbances such as floods and droughts, pests and plant diseases, as well as fluctuations in output prices. A part from high risk, most farmers have limited assets are not bankable and do not have a track record of banking or credit transactions. At the same time, creditors do not have expertise in the field of agronomy, so their risk assessment is quite complicated and their wards for the possible returns expected from each small farmer are also small. Therefore, a four partied collaboration opportunity is needed to optimize the role of banks in a smart village environment through a proposed digital-based capital assistance scheme. This proposal has the potential to be developed in Indonesia, through a model of collaboration between micro-finance institutions or cooperatives that are closer to the farmers [Santoso (2019)]. The proposal of digital-based capital assistance has not touched many farmers, but it has very good potential to be developed through the optimization of land productivity data using ABDA. The technology that can be used to support this is through the use of satellite data.

Government entities play an important role in the process of development and sustainability of smart villages because they are related to policy support and even financial support. Community entities represented by villagers, in this case, are citizens, who have previously taken the initiative to form a community. The community in general becomes a generator in various social, economic, cultural and even political activities to support development in the village. In addition to community equipment, other physical facilities such as computer networks connecting RTs, RTs, or even between villages can be optimized in this concept. Institutional facilities in the form of cooperatives that have been initiated by the community can help citizens in economic activities. This is in line with the optimization of the collaborative process of the four entities in building smart villages that need to be supported by the implementation of social science theory, especially citizen science. Therefore, at an advanced stage, this review process is carried out through the integration of papers related to citizen science.

Based on the results of a critical review of smart village research in Fig. 2 shows that the literature on smart villages has been dominated by the type of model literature and concept analysis, while the type of review literature (review/survey) is only 7%. This shows the opportunity for smart village research through a review / survey and integrated with the critical ICT review used. Based on Figs. 4 and 5, smart villages using Big Data Analytic technology reached 29%, but in particular, the use of e-commerce facilities as a data source and Sentiment Analysis or opinion mining approach was less than 2%. This shows a prospective research gap/ opportunity.

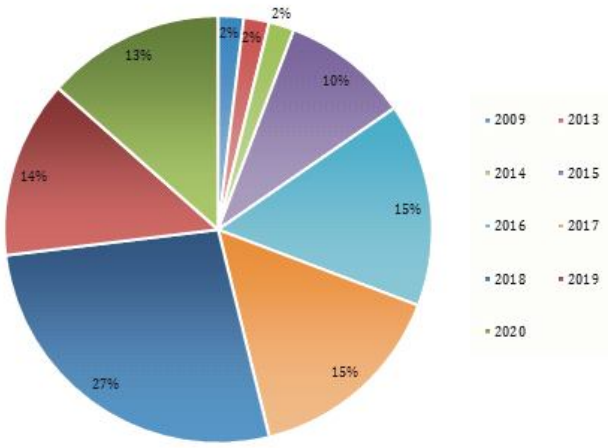

Fig. 2: Percentage of Year Published

is developing towards optimizing ICTs for water supply, sanitation, and environmental monitoring [Sharifzadeh *et al*. (2017), Jagustoviæ *et al*. (2019), Listyarini *et al*. (2021)]. Even the implementation of smart villages in some countries is more focused on providing energy which is expected to be able to increase the productivity of villagers [Groot *et al*. (2019), Garai *et al*. (2017), Hiron *et al*. (2021)].

4.2 Descriptive Analysis (Cross Attributes Analysis)

The second stage of the review process is carried out using the NVivo 12 Plus tools, through the cross-

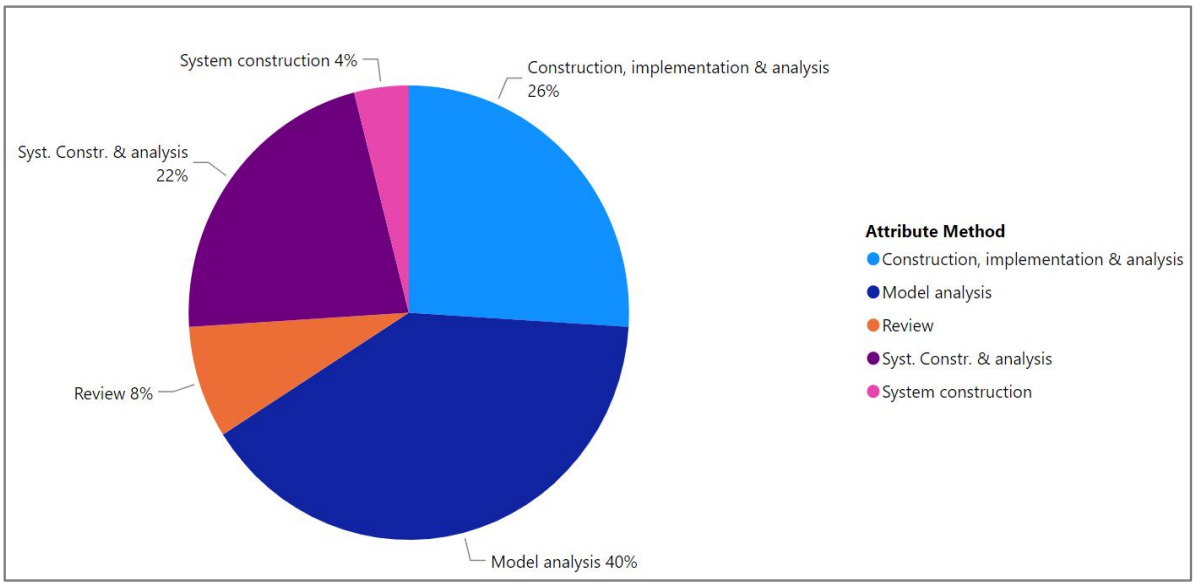

Fig. 3: Percentage of Method Types

The scope of the SDGs reviewed in smart village research (Fig. 3) spreads widely. Sequentially smart village re- search is dominated in areas of poverty, water supply, sanitation, and the environment, as well as energy, community empowerment and agriculture-related activities. This is consistent with the main objectives of smart village research proposed in Phahlamohlaka *et al*. (2014) and Azizul *et al*. (2015). The implementation of smart villages is expected to narrow the gap between cities and villages which will automatically improve the welfare of villagers, to reduce poverty levels in the village. Poverty is a major issue in smart village research, but it is still supported by the handling of other SDGs that are, such as water supply, sanitation, and the environment and energy. In poor villages water conditions, sanitation and the environment are generally poor. Therefore, smart village research

attribute facility as shown in Fig. 6 to Fig. 8.

Fig. 6 shows that smart village research experienced a significant increase in 2017 and poverty was the most studied attribute, especially in 2018. However, this condition declined in 2019 and smart village research began to shift towards health [Huang *et al*. (2018), Holmes (2017)]. The shift in the direction of smart village research can indicate the success of smart village projects in various countries. This can be seen from the development of smart villages in 2016 to 2017 dominated by the energy/electricity sector, but in 2018 and 2019 there was a decline. This condition can be interpreted that the achievement of energy targets in most villages in the world has experienced a significant increase and this can also be claimed as one of the successful implementations of smart village research.

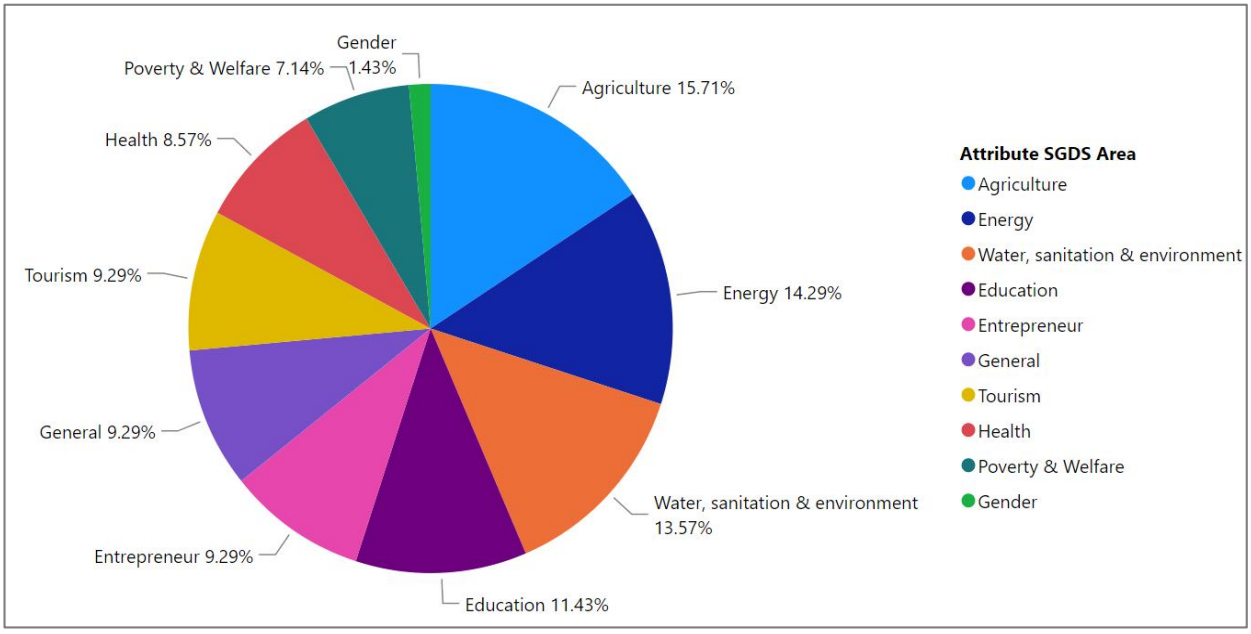

Fig. 4: Percentage of SDGs Area

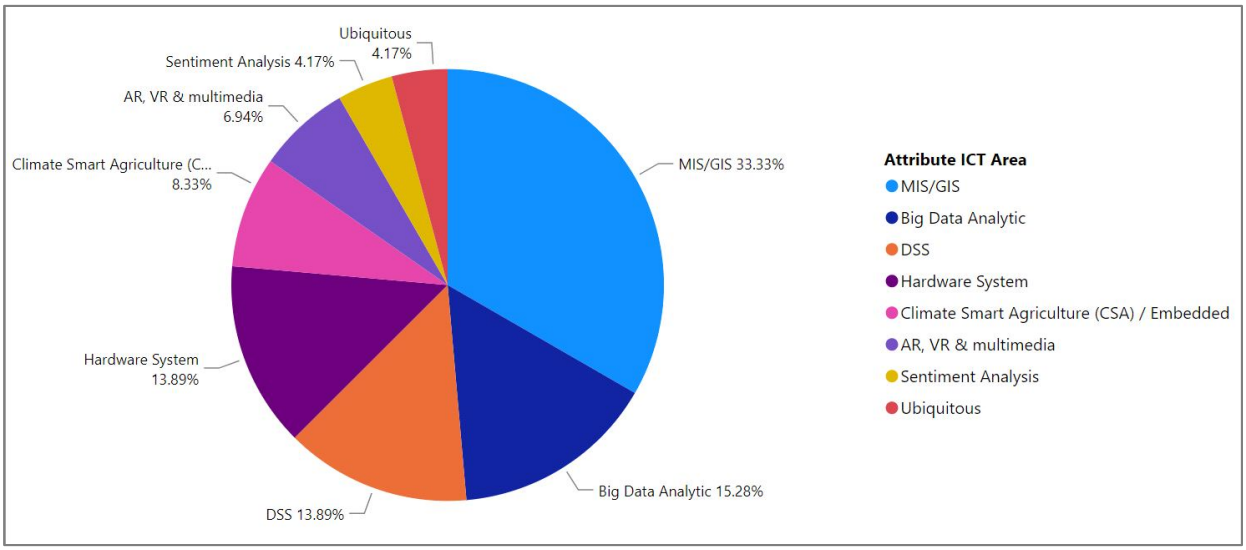

Fig. 5: Percentage Technology Coverage

The condition of smart village research that focuses on agriculture has also decreased when seen from 2016 to 2019. This has become one of the new problems that occur in rural areas with a decline in agricultural land which is replaced by housing. As is the case in Indonesia, this condition is very influential in increasing poverty and widening the gap between urban and rural areas. Therefore, it is hoped that through smart village research it will become a generator to increase agricultural productivity again through strengthening appropriate agricultural technology, including ICTs that are involved in the process of increasing farmer productivity. This condition has been reported by Tosida *et al*. (2020a, 2020b).

Smart village research involving communities and empowerment has decreased starting in 2018. This is possible because community and empowerment have become a unity in the concept of smart villages [Anderson (2019), Larsen and Estes (2019)]. As previously explained, the success of smart villages requires strong four partiet synergies to ensure their sustainability. Another interesting condition to study is the increase of smart villages in the sphere of education and entrepreneurship [Ramachandra (2015), Santoso (2019)]. Starting in 2018 smart village research focusing on education continues to increase along with the

strengthening of the human resources needed to strengthen the community of smart village implementers and monitors. Education in question ranging from formal education to non-formal education which has also involved the community of citizens, especially rural youth communities, who are increasingly aggressively strengthening collaboratively supported by the government and even received financial support from the private sector [Anderson *et al*. (2017), Afnarius *et al*. (2020)]. Strengthening entrepreneurship as one of the SDGs achievements in improving the community's economy began to be studied in 2019 [Santoso (2019), Groot *et al*. (2019)]. Local commodity-based entrepreneurs both agricultural and non- agricultural have shown significant success [Mittal and Hariharan (2018), Thornton *et al*. (2018)].

The development of smart village research methods shows that for 7 years it was still dominated by the analysis of the concept of models and system construction, specifically related to ICT system construction. The smart village re- search in the form of a review or survey is still minimal, and a lot was done in 2018. This condition shows that smart village research is still in the growth phase. It also provides a prospective opportunity to conduct a study or survey of smart villages that can involve future technology [Zavratnik *et al*. (2018), Visvizi and Lytras (2018)]. Starting in 2019 the process of smart village research that integrates system construction, implementation and analysis comprehensively has increased.

Fig. 8 shows that the development of ICTs in smart villages is dominated by automation (specifically related to the supply of electricity) and big data for agriculture and electricity. This condition has increased starting in 2016. The technology of MIS or GIS has evolved since the concept of smart villages was reviewed from 2013 to the present [Adi and Heripracoyo (2018)]. The use of multimedia technology and its development towards Augmented Reality and Virtual Reality have begun to be studied by researchers, but have not been significantly implemented in smart village environments [Tosida *et al*. (2019), Tosida *et al*. (2020c)]. Starting in 2018 smart village research has begun to shift towards the integration of a Big Data Analytic Decision Support System (DSS) based on it and even in 2019 an agricultural monitoring system involving an embedded system has been implemented [Laut *et al.* (2013)]. The use of ubiquitous ICTs has also begun to be proposed by smart village researchers because this is in line with the era of data disruption that requires optimization of computer network technology, cloud computers and the Internet of Things (IoT) [Li *et al*. (2017), Riascos *et al*. (2015), Verma and Kumar (2016)].

The cross attributes process was also carried out on three smart village attributes (methods, the scope of SDGs and ICT) and shown in Fig. 9 to Fig. 11.

The results of cross attributes of the SDGs scope and methods show that in the field of poverty and welfare is still dominated by the concept analysis method. As for the process of implementing the model and its analysis, only a few are doing it. This can be the next prospect of smart village research, especially related to the implementation of concepts/models of smart villages that are already stable to be implemented. Implementation of the concept/model of smart villages that are unique depends on the conditions and potential of each village, resulting in smart village research more interesting to discuss. Especially with the increasing ICT literacy in rural areas. This also provides the basis for conducting in-depth reviews related to ICTs used in smart villages in various countries.

The application of ICT in smart village research based on the scope of the SDGs shows that poverty has been assessed through the construction and application of Spatial Information Management (SIM), Geographic Information Systems (GIS), Big Data Analytics and even the use of the concept of ubiquitous technology has been proposed. Similar to the field of poverty, ICTs for the SDGs of clean water, sanitation, and the environment have also been studied in both modeling and application. As for the fields of energy, agriculture, community empowerment, and education have been modeled and implemented automation and Big Data Analytics. The smart village scope that focuses on education has been supported by Big Data Analytic based DSS, while for tourism through the use of multimedia, AR, and VR. This condition is supported by the statement [Vinuesa *et al*. (2020)] that the foresight technology for smart villages will be further strengthened in the DSS-based Big Data Analytic, this is supported by the disruption of data that has covered all aspects. Similarly, only the use of multimedia technology is more widely used for socialization and promotion [Santoso *et al*. (2019)]. The development of AR and VR technology for socialization and promotion has also increased along with the cheapening of

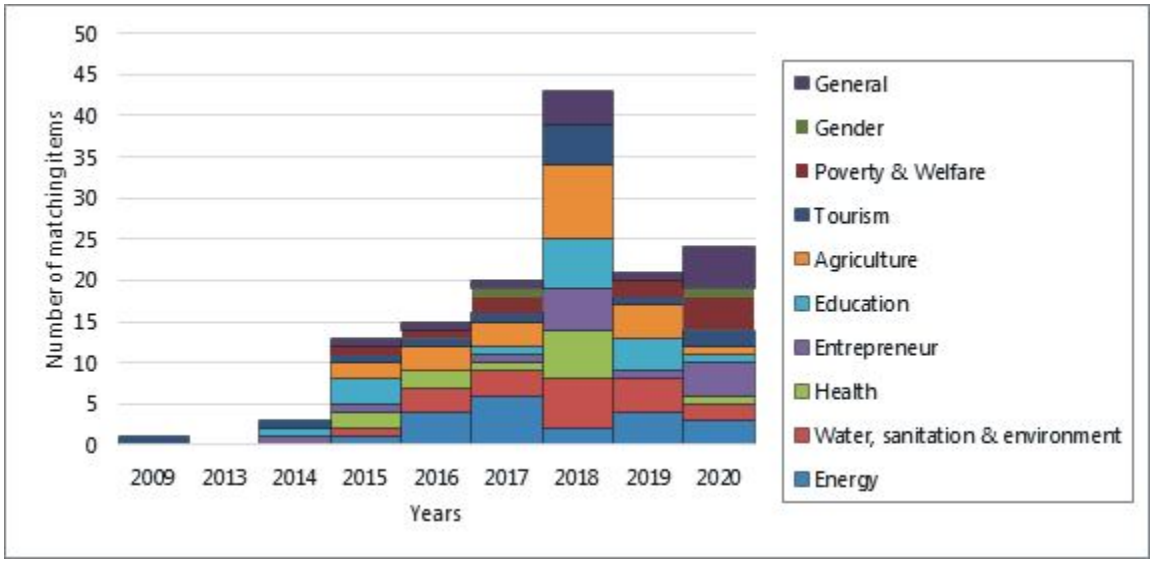

Fig. 6: Cross Attribute of Years and SDGs Area Figure

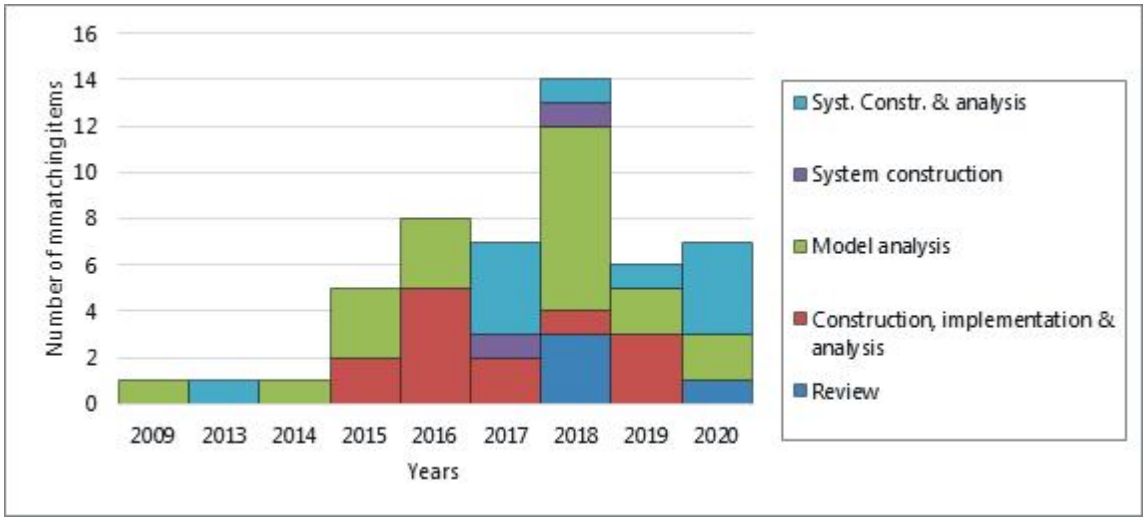

Fig. 7: Cross Attribute of Year and Method

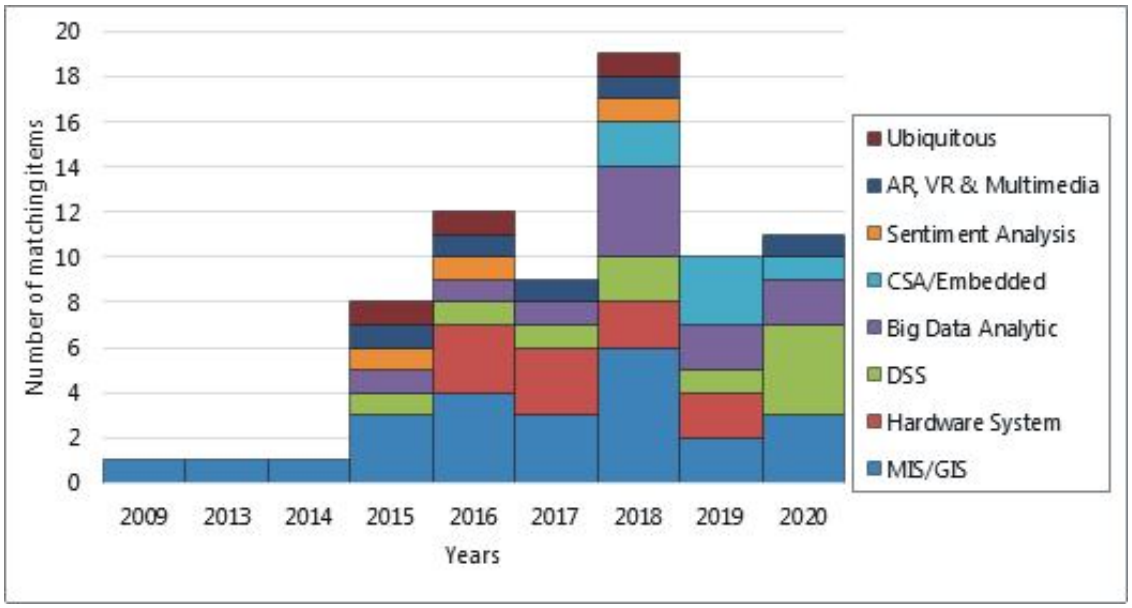

Fig. 8: Cross Attribute of Year and ICT

supporting devices [Lin *et al*. (2018)].

The application of ICT level in smart villages becomes increasingly interesting to discuss, this is proven by the increasing number of types of smart village research that can implement and analyze ICT uptake on the success of smart villages. Currently, smart village research related to Big Data Analytics is still dominated by concept/model analysis and system construction. As for automation, a lot of implementation and socio-economic analyses have been carried out on the success of smart villages. Likewise, the SIM and GIS proposed in the smart village research are only limited to system construction and analysis. This shows that ICT implementation is still a prospective opportunity for the development of smart villages. Especially when associated with social, cultural, and economic analysis, the discussion of ICT levels on the success of smart villages can be a very comprehensive study [Santoso *et al*. (2019)]. These conditions are inseparable from the strong demands of the industrial revolution 4.0 which have also entered rural life [Santhiyakumari *et al*. (2016), Gao *et al*. (2016)].

4.3 Cluster Analysis Through Text Mining Word Frequent Approach

Cluster analysis of smart village research (52 papers) integrated into citizen science was conducted with the text frequent word mining technique approach on the NVivo 12 Plus package. The word frequent technique produces the dominant word dendro gram structure that appears, as shown in Fig. 11. This dendrogram is generated through a text mining process using a hierarchical clustering algorithm and can be analyzed in-depth related to the terminology of smart village roots and its synergy with citizen science.

Fig. 12 shows that the first level of terminology roots for smart villages agreed by 44 smart village papers are based on "technology". This is by one of the components and indicators of successful implementation of a smart village that is based on the power of technology. The strength of the technology in question is certainly undergoing adaptation by existing developments. At the second level, smart village research refers to the term "community" (which is directly related to "technology") and at other branches, there is the term "energy" and "management". This can be interpreted that the most important factor of smart village development is a technology that must be able to be adopted and adapted by citizens for the benefit of the development and sustainability of smart villages [Zavratnik *et al*. (2018), Thornton *et al*. (2018)]. Because smart village research in the world from 2009 to 2020 is still dominated by energy procurement activities, this is by the next important factor that relies on the word "energy". The word "management" which appears together with "energy" shows that the next important factor in the success of smart villages in the management process. This condition is by far the best practices of smart villages that carry these four factors as reported by Phahlamohlaka *et al.* (2014, 2015).

Another very important factor in the development of smart villages can be identified through the next branch that carries the words "system", "water" "information" and "services". The development of smart villages needs to be based on a strong foundation that is related to "systems science". Several studies have shown that the model and evaluation of smart village development were successfully carried out through systems thinking approach [Jagustoviæ *et al.* (2019)]. The emergence of the word "water" at the root of terminology level two is related to the high technology needs of water supply and sanitation for poor villages. The provision of clean water in the village of Miskin, which is managed in a smart village environment can significantly increase the productivity of residents [Anderson (2019), Larsen and Estes (2019)].

Related to the term "information" the development of concepts and models of smart villages is strengthened by the conditions of the era of data disruption, industry revolution 4.0, and the implementation of big data [Manami *et al*. (2018)]. Information becomes a very valuable commodity, if managed optimally, even in most smart village research shows that information system development dominates the success of smart villages [Holmes (2017)]. Provided that all entities involved in smart village business processes can work together to manage information into knowledge and smart village development policies.

The guarantee of smart village sustainability is based on the term "services", which is very important to be applied to the smart village model and implementation. Therefore, one indicator of the success of smart village implementation is "services", this is corroborated by research results [Ramachandra *et al*. (2015), Ella and Andari (2018)]. The services referred to need to involve

four-partiet entities that synergize continuously by the agreements that have been made. At the next level, the terminology of smart villages is supported by the word's "village", "resource", "data" and "model". The term "village" and "resource" become the domain focus on developing smart village research. This is certainly in line with the main domain of the idea of strengthening villages through the optimization of village resources so that the gap between villages and cities can be narrowed [Holmes (2017)]. The "data" factor is one of the most important components of smart villages because it is related to information resources that can be optimized through ICT. Data as an information resource has a very important role especially in the development of smart villages that are increasingly converging towards ICT optimization especially for future ICT platforms through the Big Data Analytic concept. The "model" factor becomes very important to be studied more deeply because smart villages in each village have a unique character [Limaye *et al*. (2016)]. Therefore, various models or concepts of smart villages are still very interesting studies to do. This is consistent with the trends of smart village research related to models and concepts that continue to increase from 2015 to 2020 (Fig. 7).

On the third level, the terminology of a smart village is increasingly interesting because it raises 4 words that are very instrumental in the formation of a smart village. These words are "development", "local" and "rural" and "villages", which are in the same cluster. This shows that the validation of 44 smart village research has focused on village development through the optimization of local resources. In the branch word "data" has a very close relationship with the word "citizen" and "science". This shows that the success of the smart village was also influenced by the citizen science program adopted [laut *et al*. (2013), Phahlamohlaka *et al*. (2014, 2015)]. The word "citizen" is very closely related to the main actors in the development of smart villages. Villagers as the main resource play a dominant role in the success of the smart village. However, the sustainability of smart villages also needs to be supported by synergies with other parties such as the four partiet pattern. The role of four partiet is very important in the formation of a "smart community".

In the branch, the word "model" is related to the words "technologies" and "Climate-Smart Agriculture (CSA)". The condition of smart village research in several countries has been complemented by ABDA-based ICT technology, which experienced an upward trend from 2016 to 2020. One of the implementations was through CSA, with a fairly high percentage (29.27%). In the last branch of the smart village supported by the word "analysis" which is closely related to the words "research" and "climate" and "different". Smart village research still shows an upward trend, especially supported by conditions of the era of data disruption and Big Data Analytic technology, specifically related to "climate" and CSA. The condition of modern agriculture that can optimize ABDA is dominated by these CSA models [Olorunfemi *et al*. (2020), Eitzinger (2015)].

In the last branch at the last level, the results of the cluster analysis of smart village research show that the word "analysis" plays an important and dominant role because smart villages are still a growing field of research. The smart village analysis techniques proposed by the researchers continue to develop including General Morphological Analysis (GMA) [Phahlamohlaka *et al*. (2014, 2015)], Extenics Theory [Limaye *et al*.(2016)], The Nested Cluster [Visvizi and Lytras (2018)] and System thinking and Complex Adaptive System (CAS) [29]. Smart village research is very closely related to social science, therefore other success factors are "social", "time" and "study". This condition shows that smart village research is an integration of interdisciplinary sciences that complement each other.

Smart village research is closely related to citizen science research, even Laut *et al*. (2017) states that almost 70% of smart village reviews are conducted through the citizen science approach. According to Froeling *et al*. (2021) and Tulloch *et al*. (2013), citizen science especially in the field of ecology and the environment is carried out through various approaches that continue to develop. Before the 1990s, it was dominated by simple approaches but began to lead to scientific sampling and elaboration approaches [Chandler *et al*. (2017), Conrad and Hilchey (2011)]. In the 1990s, citizen science developed rapidly through the integration of simple approaches, scientific sampling, and increasingly massive elaboration approaches, whereas in the 2000s citizen participation began to develop, until 2014. According to Gurevitch *et al* (2018), the key to successful citizen science is clear objectives, data reliability, citizen empowerment, optimal

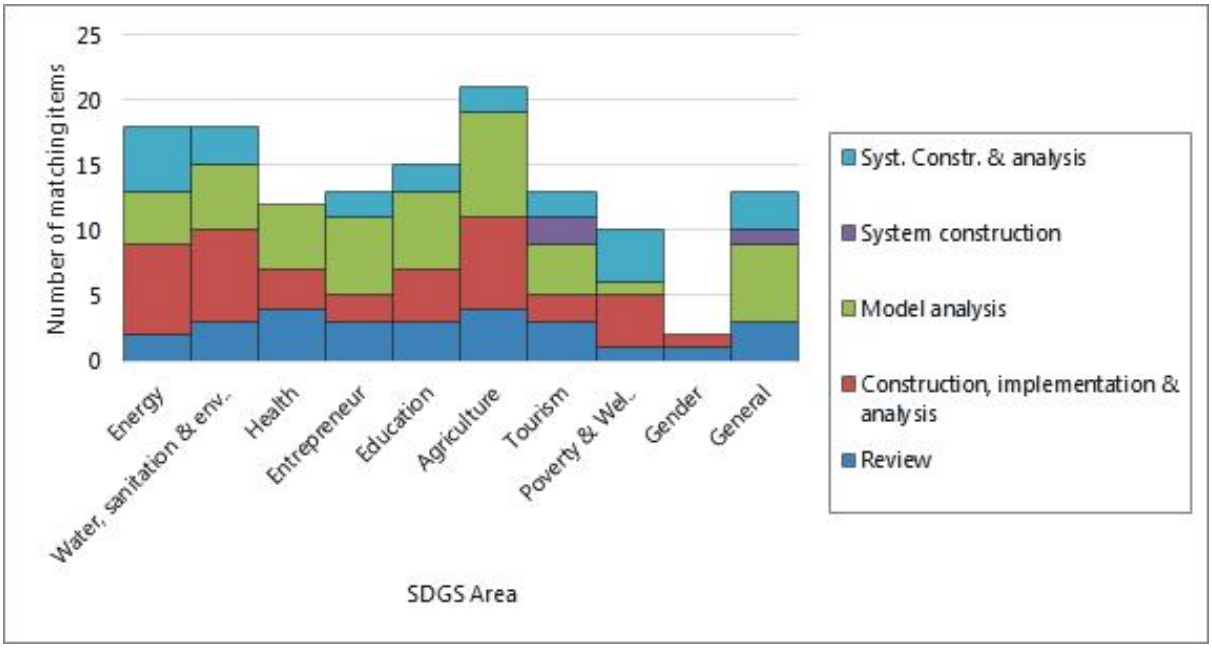

Fig. 9: Cross attributes of SDGs Area and Method

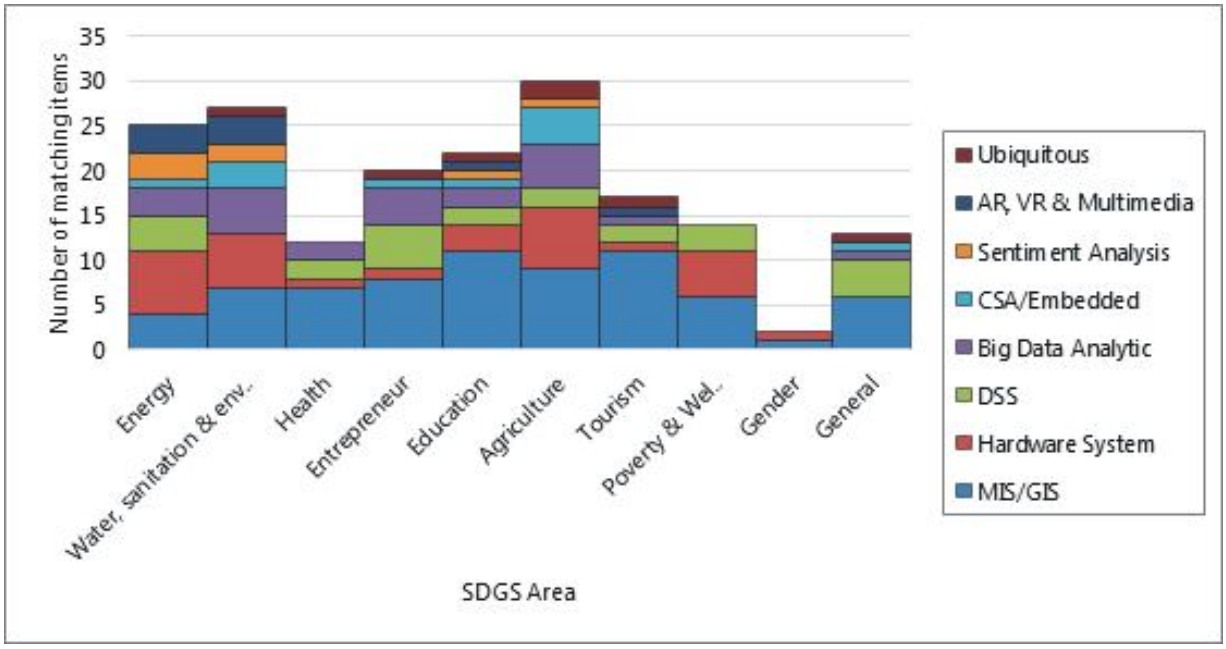

Fig. 10: Cross attributes of SDGs and ICT

communication, contribution to science, and can be a reference and develop along with research.

4.4 Research Gap and Roadmap

The SLR results show that smart village research in agriculture has indeed been done a lot through the big data analytic approach but it is still dominated by CSA based research activities carried out on-farm shown in Fig. 13. Therefore, in this research gap focused to DSS which is still narrow area (2.44%), can be developed through various integration of scientific disciplines. Smart village research that integrates social science with computer science or better known as computational social science is currently growing, and it can be used as a basis for the development of smart village research, especially related to post-harvest agricultural activities to marketing and building community strength for a smart economy. Smart village research roadmap based on Agriculture Big Data Analytic can be proposed as shown in Fig. 14.

4.5 Mapping of Smart Villages Future Research Agenda

Smart village research SLR analysis is integrated

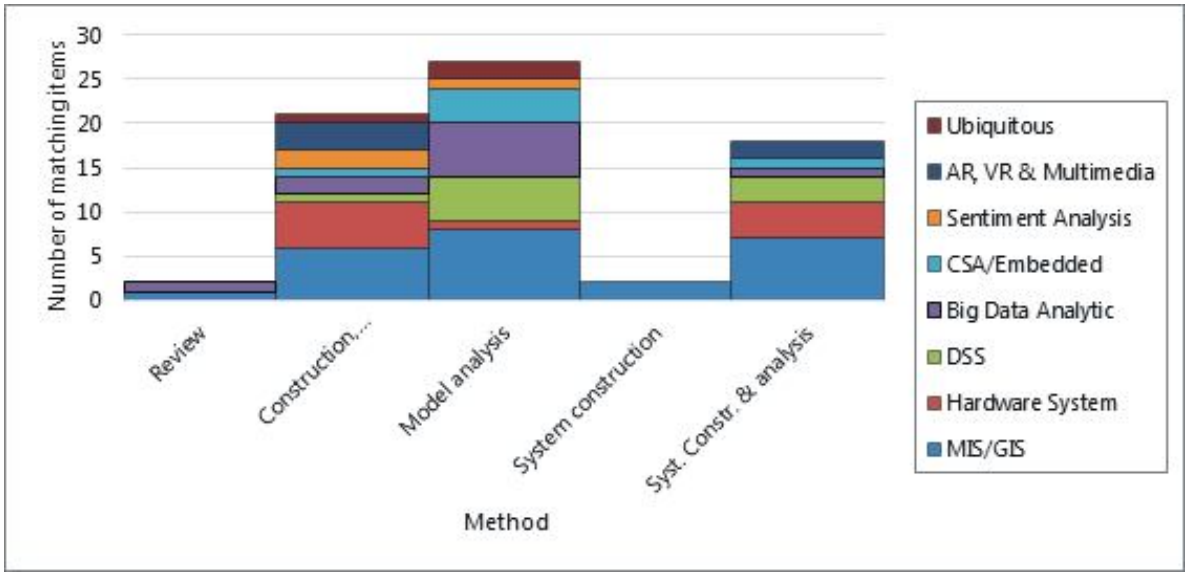

Fig. 11: Cross Attributes of Method and ICT

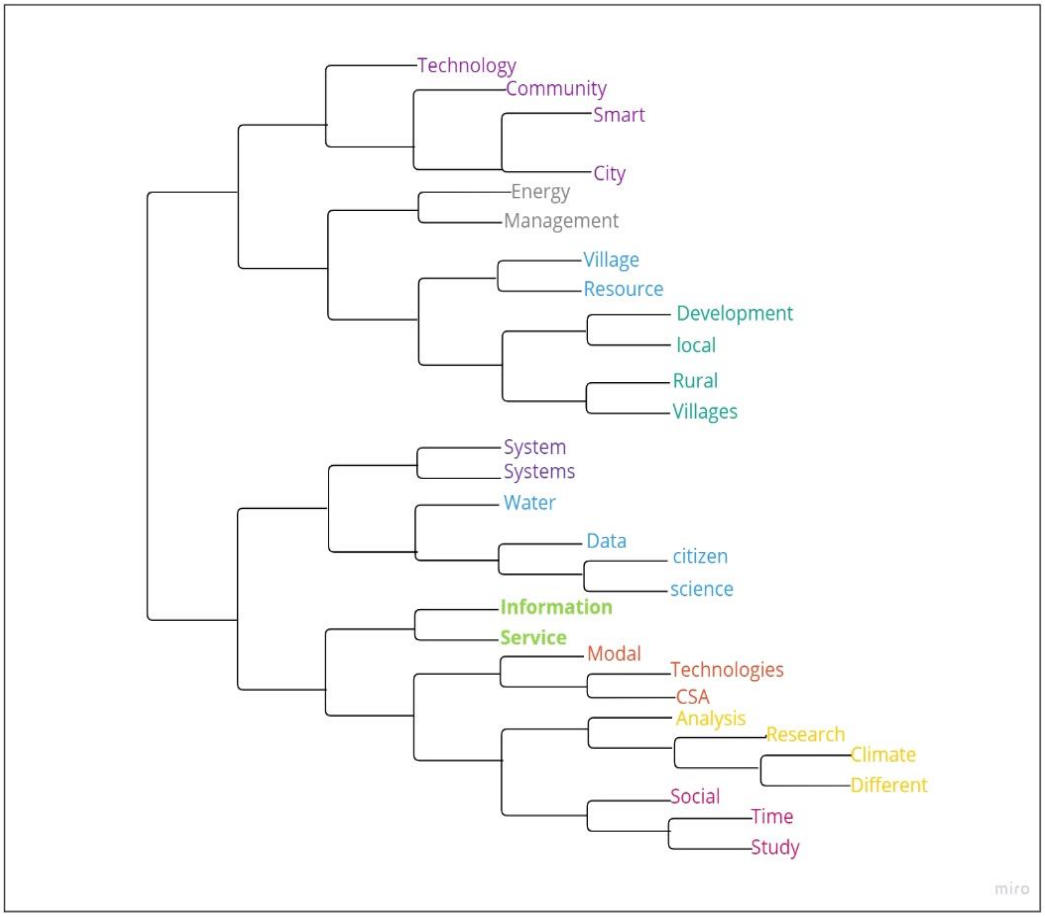

Fig. 12: Dendrogram Structure of Smart Village Research

with citizen science research using research domain hierarchy techniques as shown in Fig. 12 can be developed in more detail to produce interesting insights to be confirmed. This insight can be used as a reference for making smart village research agenda maps in the future. The results of mapping future research agendas for smart villages are shown in Table 2.

Mapping future research agendas for smart villages was built based on the results of cluster analysis (Fig. 14). The first branch shows the words "technology", "community" and ends with the words "smart" and "city". This is interpreted as the adoption of the seven

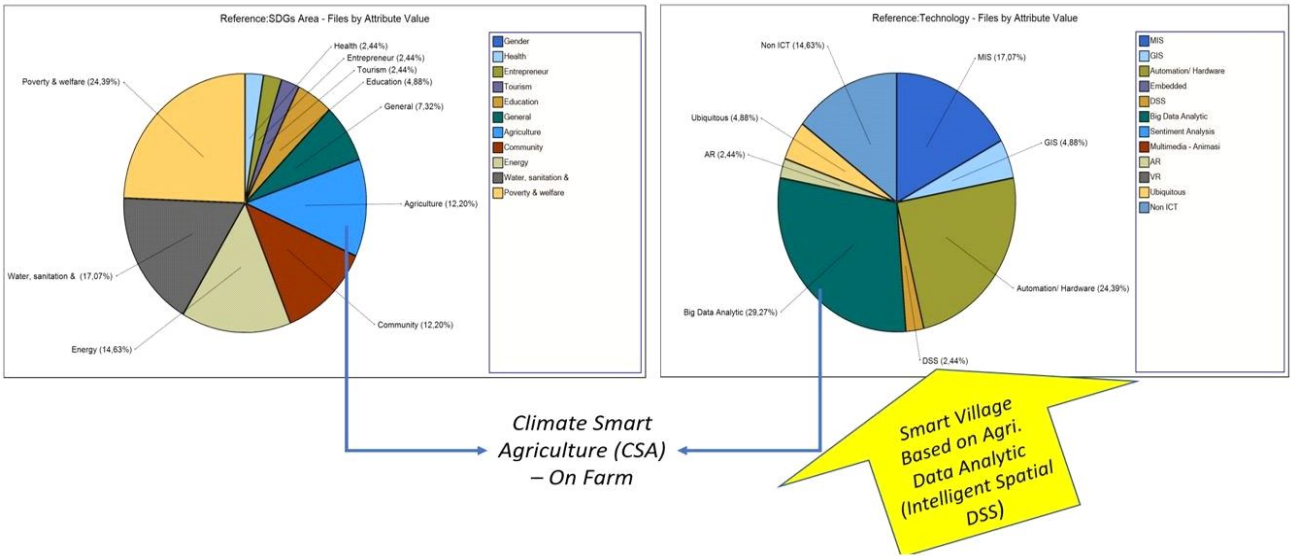

Fig. 13: Smart Village Based on ABDA's Gap Research

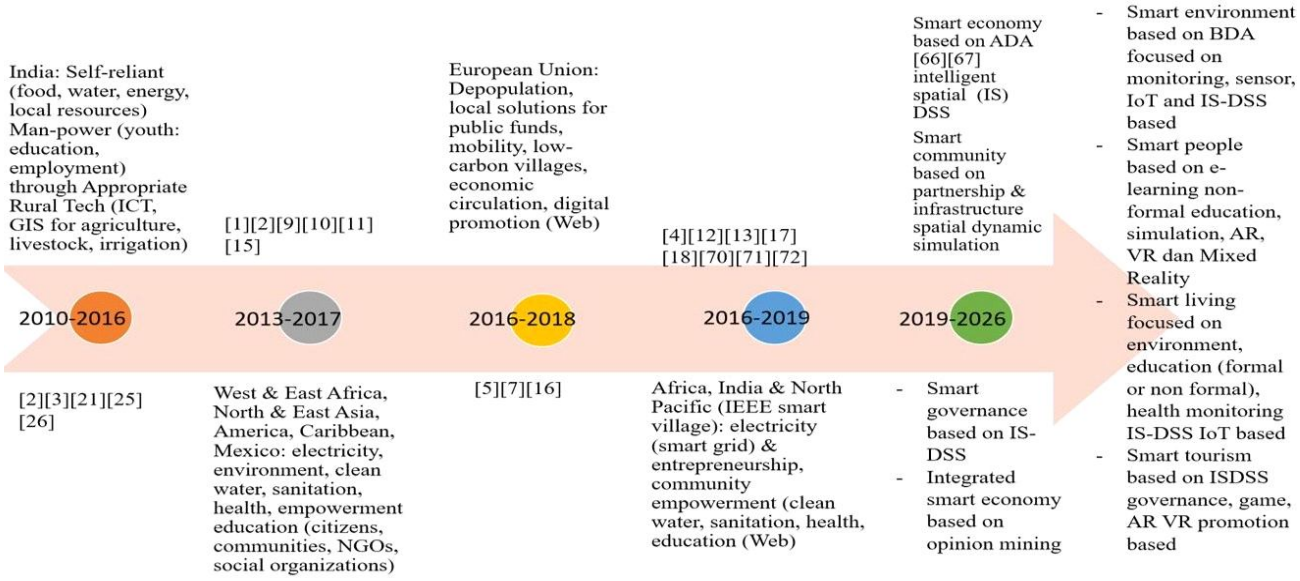

Fig. 14: Smart Village based on ABDA's Research Roadmap

dimensions of the smart city, as the initial basis of mapping. The next base is the integration of keyword analysis cluster results (the words "technology", "community", "resources" and "services"), which are integrated with one indicator of smart villages namely sustainability.

Smart village research map assessed from the integration of dimensions and indicators of success shows that the dimensions of smart mobility are still very minimal both in terms of technology, community, resource, service indicators especially related to its sustainability. The dimension used in staging the smart village research agenda still refers to the smart city dimension. According to Santoso *et al*. (2019) smart mobility includes activities related to public transportation facilities which include local accessibility and a safe, innovative, and sustainable transportation system. In the smart village research that has been reported, transportation media has not been a priority.

This condition is different from smart city research, which is very focused on building innovative transportation media, especially those capable of reducing carbon emissions. Except in the case of smart villages carried out by ENRD, which are very focused on smart mobility to shorten the distance between villages and cities with the concept of smart auto stop (hitch-hiking) service. This concept carries sustainable mobility services. The service is established as a social

enterprise that brings together different groups that have an interest in mobility: local authorities; transport operators; associations; foundations; users; employees. More than 1500 French municipalities have enrolled.

This is different from the condition of the development of smart village research in the Asian region which generally still focuses on the smart environment and smart living through the provision of energy [Sharifzadeh *et al*. (2017), Prinsloo *et al*. (2016)], clean water, sanitation [Ramachandra *et al*. (2015)] and improving the welfare of villagers [Santoso *et al*. (2019)]. Therefore, the smart village research map is still dominated by the high absorption of ICTs for the automation and monitoring of energy, water and increased community productivity for poverty reduction and strengthening the welfare of citizens. Strengthening the welfare of villagers through entrepreneurial strengthening also shows a significant development even this condition is integrated with the productivity of villagers who mostly work as farmers [Assumpcao *et al*. (2019), Mittal and Hariharan (2018)]. In other conditions the success of the role of the local community, which was transformed into smart people and smart community has been able to optimize the fields of education [Holmes (2017)], health [Huang *et al*. (2018)], entrepreneurship to create a smart economy for the region [Azizul *et al*. (2015), Phahlamohlaka *et al*. (2014)]. Smart economy can then be built with a model of cooperation between local communities and the private sector in terms of providing productivity-based capital assistance. This research agenda is very interesting to study because in Southeast Asian countries like Indonesia the level of accessibility of farmers to banks is still low due to many factors. Therefore, through the support of ICT technology in particular the capital productivity model based on land productivity is one of the next research agendas. This research agenda needs to be comprehensively studied not only related to the model and system construction but more broadly in the economic, social, cultural, and political analysis that applies in the region. Support for big data analytics related to land data sources based on satellite imagery becomes very important, besides the integration of DSS and GIS.

The level of sustainability of smart villages can be assessed from the ability of stakeholder synergy in managing smart village projects. In general, smart villages that are sustainable and developing, are even able to form and initiate components of smart villages independently supported by four partied, which **cones** on smart governance. On the other hand, the results of research on smart governance are still dominated by the construction of models and systems, whether in the form of SIM, GIS or DSS [Salim (2013)]. There is also smart governance that has been implemented and then analyzed comprehensively (social, economic, cultural, technological, and sustainability) [Santoso *et al*. (2019)].

The future research agenda for smart villages assessed from the perspective of ICT development has very diverse levels, but according to the priorities of each region. By the statement [Thornton *et al*. (2018), Visvizi and Lytras (2018)], the level of ICT becomes a very important factor for the development of smart village research. Sensor automation and optimization, IoT, DSS, Big Data Analytics have been widely implemented for CSA or ABDA (focus on production to post-harvest) and smart grids. The scope of the smart village dimension that can be adapted by CSA, ABDA, and smart-grid is smart living and smart environment, through increasing citizen productivity and increasing environmental quality.

Smart village research that examines the added value of the formation of smart living and smart environment on improving the economy to form a smart economy is a very interesting research agenda and has not been done much. The added value study certainly needs to involve comprehensive ICTs by the era of data disruption through the implementation of the concept of big data, data analytics, data mining, artificial intelligence. Even the integration of sensor technology, biosensors, virtual reality, augmented reality and 5G technologies can strengthen added value [Ranade *et al*. (2015)]. Especially, if it is supported by the role of fourpartite in its management. Data sources are available massively through social media, online news media, and other media as ABDA resources that can be optimized to form a citizen science-based smart economy.

The future research agenda for the next smart village (Table 2) is the integration of smart living and smart environments to generate added value in the sociocultural and political aspects of the villagers through ICT-based smart people studies. Smart people in the context of smart villages can be developed through non-formal education which is initiated and managed well by the local community in collaboration

Table 2: Mapping of Smart Villages Current and Future Research Agenda.

No.	Indicator/ Dimension	Technology	Community	Service & Continuity	Future Research Agenda
1.	Smart Governance	Village Information System [Salim (2013)], Model / GIS concept [Marlintha *et al.* (2013)] GIS-Building [Afnarius *et al.* (2020)]	Four partietactor collaboration [Holmes (2017)], Village officials [Afnarius *et al.* (2020)].	Online and offlinecombination [Ramachandra *et al.* (2015)], Update data, evidence based [Holmes (2017)]	Smart governance DSS-GIS based
2.	Smart Economy	CSA [Jagustović *et al.* (2019)] Big Data Yield Predict ton model [Assumpcao *et al.*(2019)]	NGO [Groot *et al.* (2019)], Local Community [Santoso *et al.* (2019)].	Business Expansion [Thornton *et al.* (2018)], MSMEs agriculture-based and non-agriculture based [Groot *et al.* (2019)]	A smart economy based on ABDA focused on opinion mining
3.	Smart Mobility	Smart auto stop [ENRD (2018)]	Local authorities; transport op-orators; associations; foundations; users; employees [ENRD (2018)]	Car-sharing, short journeys organized at short notice & Social enterprises [ENRD (2018)]	Smart mobility based on BDA focused on user, employees, tracks and social enterprises
4.	Smart Environment	Internet, video channel, Radio [Mishra *et al.* (2018), IoT [Pham *et al.* (2016)], Smart Grid [Anderson (2019)], Intelligent based Micro Grid [Prinsloo *et al.*(2016)], Low Carbon monitoring [ENRD (2018)], Water monitoring [Pham *et al.* (2016)].	Local commu-Nity [Garai *et al.* (2017)]	Multi actors managingelectricity [Malche and Maheshwary (2017)], clean water, water pipe well lane [Larsen and Estes (2019)]	Smart environment based on BDA focused on monitoring, sensor, IoT and DSS-GIS based
5.	Smart People	Model Opinion Mining [Adi *et al.* (2017)]	Local Communities [Ramachandra *et al.* (2015)].	Nonformal education for the young man [Marlintha *et al.* (2017)]	Smart people based on e-learning non-formal education, simulation, AR, VR
6.	Smart Living	CCTV [Santoso *et al.* (2019)], Model smarthealth (sensor, AI) [Huang *et al.* (2018)]	LocalCommunity [Adi and Heripracoyo (2018)]	Cooperatives & SMEs in managing electricity Mom and children Health [Ramachandra *et al. (2015)]*	Smart living focused on the environment, education (formal / non-formal), health **monit**. DSS-GIS-IoT based
7.	Smart Tourism	AR [Lin *et al.* (2018)], Web [Santoso *et al.*(2019)], GIS [Afnarius *et al.* (2020)]	Tourism Group Driven [Santoso *et al.* (2019)], Village Officials [Afnarius *et al.* (2020)]	Infrastructure, activity [Lin *et al.* (2018)], Digital Destination, e-ticket [Santoso *et al.* (2019)], GIS-Building [Afnarius *et al.* (2020)].	Smart tourism based on DSS-GIS governance, game, AR and VR promotion based.

with universities. The sustainability of smart people is influenced by the consistency of the local community in carrying out the program [Tosida *et al*. (2020a, 2020b, 2020c)]. Local communities can be initiated by citizens/ youth even those who have the opportunity to become students/students, and have good ICT support and knowledge, to collaborate with academics in carrying out non-formal education for citizens by the needs of their profession and environment. This condition will be more interesting to be the agenda of future smart village research if local communities can create non-formal educational programs equipped with interesting, creative and integrative learning media based on AR [Tosida *et al*. (2019)] and VR and equipped with a MIS that is integrated with the SID. Educational management systems in smart villages can also be developed by integrating AI technology related to education mining, opinion mining, and sentiment analysis, which can be used to support educational policies in the region. Smart people as the embryo of smart communities will be stronger if supported by smart village infrastructure collaboration. Smart village infrastructure in question includes three main components namely infrastructure (ICT and non- ICT hardware, software and NetWare), institutions (local communities, cooperatives, MSMEs, academics, private and government), and regulations. The synergistic infrastructure model research agenda to form a smart community is one of the potential research agendas.

Many rural areas have now been developed through tourism. Therefore, smart tourism has become a potential research agenda for development, especially related to increasingly massive ICT technology. Various models and information systems for village tourism management have been developed (MIS, GIS, DSS-GIS based), although some research has not been implemented comprehensively until economic, social, cultural, political, and sustainability analysis. Therefore, with the development of sensor technology, IoT, big data, analytic data can be used and implemented for the development of smart tourism [Laut *et al*. (2013), Olorunfemi *et al*. (2020)]. This can include a promotion, management, and monitoring systems. The smart tourism research agenda through the promotion system can even be integrated with the educational-tourism model by utilizing AR, VR and Mix Reality technologies.

5. Conclusion

Smart villages as an effort to reduce poverty and narrow the gap in rural and urban development is one of the solutions carried out by various developing countries. The main objective of this research is review and preparation of a future research agenda for smart villages, which is focused on strengthening the ICT level especially the concept of agriculture big data analytic. SLR of smart village conducted through descriptive analysis (single and cross attributes as well as a hierarchy of attributes and research domains) and clusters (word frequent analysis), with the NVivo 12 Plus software, it can produce confirmation of the variable structure of smart village success and future research agendas. The attributes involved in this research are the year of publication, the methodology, area of SDGs and technology. SLR is not only carried out on smart village papers but at the cluster analysis stages integrated with papers related to citizen science.

The results of a description of the analysis of the SDGs area showed that smart village research is dominated by the provision of energy, water, sanitation, and the environment, agriculture and improving the welfare of citizens. SDGs in the areas of education, health, and entrepreneurship are still lack, especially smart village research related to gender is still very minimal. Most of the previous authors applied model/ concept construction method, and there is lack of discussion about implementation and comprehensive analysis of the smart village system. The level of technology that is modeled, instructed, and implemented in smart villages also spreads widely, but MIS, GIS, Automation and Big Data Analytics in agriculture especially CSA are more dominant, but lack of application about ABDA post-harvest especially using topic mining for marketing, price prediction and collaboration institution. The implementation of big data analytics for added value to the community's economy, which is comprehensively integrated (social, cultural, political and sustainability) has not been much studied in the area of smart village research. The results of the cross attributes analysis show that ICT trends still lead to the level of AI, big data analytics, IoT, sensors, AR, VR and 5G technologies.

Cluster analysis on smart village research generates novelty related to the confirmation of the structure of the smart village success variables formed through the text mining approach to frequent text techniques. Four main variables (technology, community, resources and service/sustainability) have been confirmed. The results

of the second phase of cluster analysis conducted with the integration of research papers related to citizen science also produced a very interesting variable structure that enriched the study of smart village research, which was then elaborated on a map of future research agendas.

The future research agenda of the smart village is carried out through the elaboration of four success variables and the seven dimensions of the smart village. There are seven future research agendas for smart villages: DSS-GIS based smart governance; Smart economy based on ABDA focused on opinion mining; Smart mobility based on BDA focused on users, employees, tracks and social enterprises; Smart environment based on BDA focused on monitoring, sensors, IoT and DSS-GIS based; Smart people based on non-formal e-learning education, simulation, AR, VR, and MR; Smart living focused on the environment, education (formal or non- formal), health monitoring DSS-GIS-IoT based and Smart tourism based on DSS-GIS governance, games, AR and VR promotion based.

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Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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