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Review of Studies on Smart Rural and Rural Resilience

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***Abstract*— Smart cities have been the highlight in many developed countries, such as the European Union (EU) region. The countries in this region have shown significant advances in their socioeconomic conditions over regions that do not practice the smart city concept. Consequently, smart rural or smart village is also getting more attention especially with countries that have large rural areas. The smart rural idea was derived from the smart city concept but is implemented within the rural context. Thus, it might achieve similar outcomes as smart city, such as enhancement of livelihood and quality of life that resulted from the boost of socioeconomic development. Therefore, a review of past studies has been conducted to find the knowledge gaps and to explore the research trends for these two concepts in the socioeconomic aspect. It was found that smart rural was widely studied in the year 2020 and 2022, with smart rural and rural resilience studies were mostly focused in countries of the EU, namely Poland, Scotland, and Czech Republic. Furthermore, it was also found that these two concepts are not yet correlated with each other in past studies within the same context, however it can be connected with the consideration of sustainable rural development. Thus, from this literature review, there is still more research needed to be done especially with the topic of socioeconomics with both smart rural and rural resilience concept.**

***Index Terms*— smart rural, rural resilience, socioeconomic, rural development.**

I. INTRODUCTION

In rural areas, socioeconomic development is crucial for improving the living conditions and well-being of rural communities. The implementation of smart rural development strategies can contribute significantly to achieving positive socioeconomic impacts in rural areas (Shaik, 2017). Rural areas often face unique challenges, such as limited access to resources and infrastructure, lower employment opportunities, and a declining agricultural sector (Mukti et al., 2021). However, the use of smart technologies and innovative approaches can help overcome these challenges and foster rural resilience (Zhang & Zhang, 2020). One of the major challenges faced by rural areas is the limited access to internet and electricity (Chowdhury et al., 2023). According to the European Union (EU) Rural Review, less than half of rural homes have internet access compared to over 80% in urban areas (Rey-Alvite & Fernández-Crehuet, 2020). Additionally, more than 1.3 billion people globally lack access to electricity, which further hinders socioeconomic development in rural areas (Rey-Alvite & Fernández-Crehuet, 2020; Lata & Kumar, 2022). Therefore, to address this issue, inclusive digital transformation is crucial, and this is where smart rural plays its part in supporting the resilience within the rural areas to have a positive impact on its socioeconomic condition. Additionally, by incorporating principles of smart rural development,

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such as implementing digital technologies, promoting sustainable tourism, and fostering rural innovation, rural planning can contribute to building a diverse and resilient rural economy (Dandekar, 2001).
Consequently, in Malaysia, the huge socioeconomic divide between East and Peninsular Malaysia urged the Malaysian government to focus on socioeconomic development in East Malaysia in the Twelfth Malaysia Plan (RMK12) (Salim, 2021). This project will address household incomes, education, employment, community safety during natural catastrophes, social and governmental support, and rural resilience from a socioeconomic perspective (Salim, 2021). Recent literature from Ambau et al. (2023) where socioeconomic development was studied in the rural area of Belaga, Sarawak showed that there were still many infrastructures needed to be improved. Although there are many activities that promotes large-scales infrastructures projects in rural areas – namely the hydroelectric dam project in the study area, there is still room for further development in terms of accessibility to improve rural living conditions (Ambau et al., 2023). Therefore, this further reiterates that over the past year, the socioeconomic development in Sarawak still needs to be improved despite having development projects lined up due to the rural community's need to enhance their living conditions. Additionally, smart rural development and rural resilience are new concepts that have yet been addressed in policymaking in Malaysia (Poh et al., 2019) as the focus in policymaking is still in urban development where smart city is a priority (Lim et al., 2021). Although the RMK12 plans to focus on rural development in its' planning (Abdul Rashid et al., 2021), smart rural has yet to be included in its' policies and development strategies.

II. Definitions

A. Smart Rural

There is still no standard definition for smart rural. However, several scholars have made attempts on defining the concept with their own interpretations. Neal et al. (2017) had defined smart rural to be a community that is creative in ways to invent new sources of value as such in enhancing life quality for rural communities. On the other hand, Naldi et al. (2015) stated that smart rural indicates achieving economic growth, where the rural community's smart growth supports sustainable development. Maja et al. (2020) studied the various indicators to measure smart rural, namely, access to affordable energy, adequate housing, safe drinking water, an inquisitive rural culture, early warning systems against adverse weather conditions, water pollution, and a predictable schedule for the local doctors all contribute to making a rural area smart. In general, smart rural can be defined as a sustainable living condition in the rural areas with the help of technology with easier access towards outside sources whenever needed.

B. Rural Resilience

Rural resilience was studied as a new development concept by Heijman et al. (2007). Whereby, the author defined that rural resilience is the ability of the rural community to resist, transform, and adapt to changing environment. Li (2022) has a similar view on rural resilience and defined the concept as a rural region's ability to adapt to changing conditions changing external circumstances in such a way that a reasonable standard of living is preserved. This also involves recovering from management or adversity due to government oversight (Li, 2022). Rural resilience is critical for preserving rural stability and people's living standards in the face of hazards and unforeseen obstacles (Lata & Gupta, 2021). Furthermore, for rural areas to be resilient, they need to have access to health care, insurance, and have a stable income (Bryant & Cooper, 2021).

III. Review Methodology

Multiple databases were used to identify the sources for this literature review. The main databases used on the Curtin Library website were Science Direct, Scopus, and Web of Science. These databases were selected due to their extensive literature collection. The search terms selected for this literary analysis were*smart rural/village, rural resilience, sustainable rural development,* and *rural socioeconomic*. These terms were combined in various ways with "AND" commands in an effort to obtain relevant articles (Kumar and Lata, 2022).
There were two stages to the screening process. The first stage includes the selection of past literature based on the suitable title. There is no restriction on the publication year in the literature search process. The earliest literature was published in2015and the latest literature was published in 2024. Reviewing literature published in various years enable the authors to compare the focused issue among the previous studies. Next, the selected articles will be finalised in the second stage after reading the abstract, discussion, and conclusion. After both stages were completed, the remaining sections of the articles were scanned through, including the introduction, literature review, etc.

After identifying the valid literature, the following information will be analysed: publication year, country or region where the studies were conducted or focused on, and the research theme. After analysis, the research gap will be identified for further discussion, and notable aspects of future studies will be mentioned. Figure 1 shows the flow of the overall research framework.

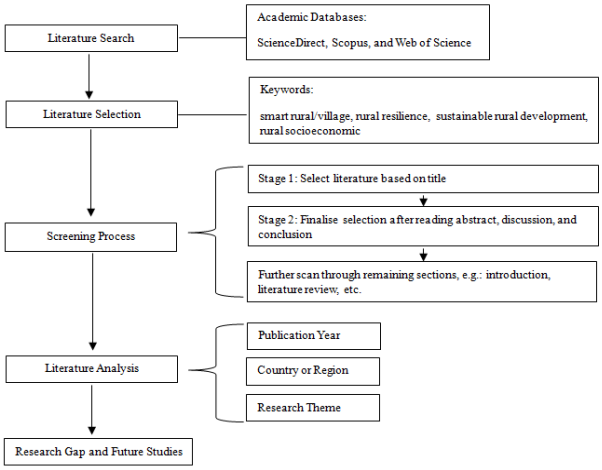


Figure1: Flow of Overall Research Framework

Table 1 shows the total number of valid articles after the screening process.It shows that the most articles selected were from ScienceDirect followed by Web of Science and Scopus. The total number of valid articles selectedto be reviewed was43 articles.

TABLE 1: TOTAL VALID ARTICLES FOR EACH DATABASE

Database	Stage 1	Stage 2
ScienceDirect	46	22
Scopus	20	11
Web of Science	22	10
	Total	**43**

IV. OVERVIEW OF SMART RURAL DEVELOPMENT

A. *Distribution of Literature Over the Years*

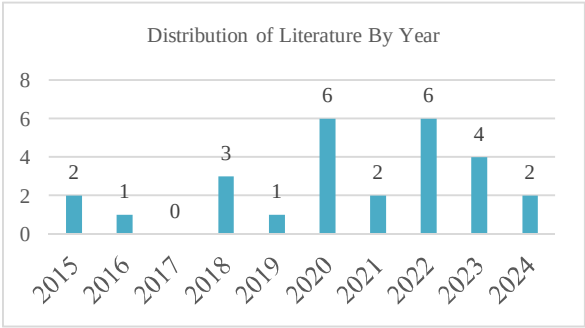


Figure 2: Distribution of Literature Over the Years

Based on the outcome of the literature review, the earliest publication on smart rural was in 2015 by Naldi et al. (2015) and Srivatsa (2015). They discussed that smart rural can be achieved with the help of sustainable rural development (Naldi et al., 2015) and the affected equilibrium of demographics due to rural-urban migration (Srivatsa, 2015). This was followed by Tahir (2016) in 2016 with studies regarding telecenters in rural areas of West Malaysia. Then, studies in 2018 were done by Scherbina and Gorbenkova (2018), Guzal-Dec (2018), and Fennel et al. (2018). Next, Slee (2019)studied the policiesdone bythe Scottish Government in 2019, thus presenting the conditions to kick offsmart rural in Scotland.The recommendations to improve smartness in rural

areas were strengthening the sense of community through activism, setting policies for place-based community development, and integrating spatial targeting to focus on less advantaged rural areas to have an opportunity in their local development plans (Slee, 2019).

Next, it can be observed that there was a surge of publications on smart rural in the years 2020 and 2022,as shown in Figure 2.This might be due to the considerable efforts done by the EU government through proposals and project designed for smart villages in the EU on the final quarter of 2019 to the second quarter of 2020 (European Network for Rural Development, 2021).In the year 2020, scholars voiced their concernsofrural areas not catching up with modern technologies. For instance, Cowie et al. (2020) stated that the 4th Industrial Revolution (4IR) is only centred around urban development and rural development is being left out and this scholar proposed that rural development experts should refer to smart city theories to understand the aspects in transitioning rural areas to support smart rural. Additionally, Maja et al. (2020) had established some indicators for smart rural that aligns with the 4IR. These indicators included adequate housing, access to safe drinking water, and inquisitive rural culture (Maja et al., 2020).

Based on the literature review, studies on implementation works for smart rural areas started in 2022. Particularly, a study by Kagungan and Rosalia (2022) studied smart rural development in Indonesia, emphasising creating more intelligent rural communities and tourism. It was found that the smart rural villages had utilised information technology in their governing administration, fully participated in their rural communities, and took advantage of their environment without exploiting its resources (Kagungan & Rosalia, 2022). Furthermore, in 2023, researchers seem to have explored literature regarding the effects and opinions of parties involved in smart rural implementations. For instance,Hlavacek et al. (2023) studied the limitationsof smart rural, where they found that the local government is more cautious about smart rural implementation projects than development experts. This is due to the lack of information on the benefits of smart rural projects and the restricted financial resources to implement these projects. Therefore, they do not have a clear standpoint (Hlavacek et al., 2023).

There are two literature published in 2024. The first study was conducted by Tosida et al. (2024), a spatial-based infrastructure model was proposed to encourage a smart environment in smart villages in Indonesia. This study recommended using community village infrastructures to develop a sustainable and smart economy village (Tosida et al., 2024). Meanwhile, Jayawinangun et al. (2024) proposed the use of communication network in developing a smart community in the rural areas. The research showed the importance of an effective communicative pattern among smart rural stakeholders to strengthen the economy in the villages (Jayawinangun et al., 2024). This shows the crucial role of social aspect in communication in supporting smart rural development.

B. Distribution of Literature by Country

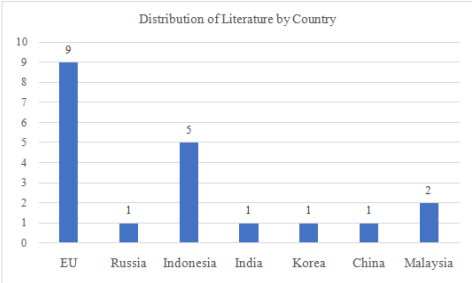


Figure 3: Distribution of Literature by Country

Figure 3 shows the distribution of publications by country. Most of thesmart rural literature werefocused on the EU regions. Based on the articles, the earliest study of smart rural was also focused on the EU, which was done by Naldi et al. (2015) where smart rural was studied conceptually in Sweden.According to the EU documents, the smart village concept had been implemented since 2017 (Guzal-Dec, 2018). Guzal-Dec (2018) also studied the smart rural concept during its initial implementation phase. In this study, Guzal-Dec (2018) mentioned that smart rural might help with social and technical innovations in the EU, which could increase the territorial assets of the rural areas in the region. The author had also identified the limitations that might affect the implementation of smart rural in the EU, including low community spirit, low levels of openness to change in rural communities, geographical distance, and inadequately planned transportation and communication networks (Guzal-Dec, 2018).

Next, 5 of the articles were found to be focused on smart rural in Indonesia. This is due to the lack of studies on smart rural as most researchin Indonesia only focuses on the smart city to improve its urban development (Mukti

et al., 2022). Mukti et al. (2022) also strongly suggest that smartness needs to extend beyond urban areas to narrow the urban-rural socioeconomic gap and prevent stress and overload on urbanisation problems caused by rural-urban migration in Indonesia. Additionally, Aziiza and Susanto (2020) stated that although smart rural has already been implemented in Indonesia, it only focuses on public services, which covers only a small part of the smart city concept. Therefore, Indonesia has more rural development opportunities to explore besides the public services aspect of smart rural. Thus,Kagungan and Rosalia (2020) suggested other aspectsof smart rural that can be integratedinto local regulations, such as – technology, living, resources, village services, tourism, and governance.Indonesia started exploring other aspects of smart rural in 2024. For instance, Tosida et al. (2024) studied the smart economy through a spatial-based infrastructure model, while Jayawinangun et al. (2024) studied the effective communications to support the smart economy in Indonesia.

Furthermore, 2 literatures were found to be focused in Malaysia. The first article was from Tahir et al. (2016), and the author suggested that telecenters might help develop smart rural areas in Malaysia. Telecenters were set up in rural areas in West Malaysia to familiariseICT within rural communities (Tahir et al., 2016). Tahir et al. (2016) strongly feel that this effort can introduce ICT to the rural areas in Malaysia as it can offer exposure to the closed rural communities and grant access to education to the rural population to narrow down the digital divide between rural and urban areas, thus improving the socioeconomic status of the rural communities in Malaysia. In the socioeconomic aspect, having access to education would greatly impact rural dwellers' employment rate and income, thus decreasing the poverty rate in rural areas (Tahir, 2016). This was followed by a study by Abdul Rashid et al. (2021), who identified the key elements to modernise rural areas in Malaysia, hoping to lead to smart rural development. Modernisation of rural areas was studied to align the smart rural concept with the technologies of the 4IR through the key elementsthat consist of rural economic and infrastructure, social well-being, and smart and green technology (Abdul Rashid et al., 2021).

Other countries that were found to have studied the smart rural concept were Russia, India, Korea, and China. In Russia, smart city technologies were studied to achieve sustainability in smart rural development. This was studied by Scherbina and Gobernkova (2018), and they proposed a smart village model that includes smart city features that consist of smart economy, smart technology, smart society, smart ecology, and smart administration. Similarly, smart city strategies in India were linked with smart rural policies to ensure youth employment through information and communication technology (ICT) (Fennell et al., 2018). The author stated that the rural youths in India found that ICT had improved their access to education and consequently increased their chances of employment (Fennell et al., 2018). On the other hand, in Korea, Cho and Park (2023) identified the factors for achieving a sustainable smart rural community. They concluded that social factors, including cultural and human aspects, were more crucial than technological structures. However, in China, Zhang and Zhang (2020) realise the importance of integrating ICT into smart rural to promote sustainable rural development.

C. Distribution of Literature by Themes

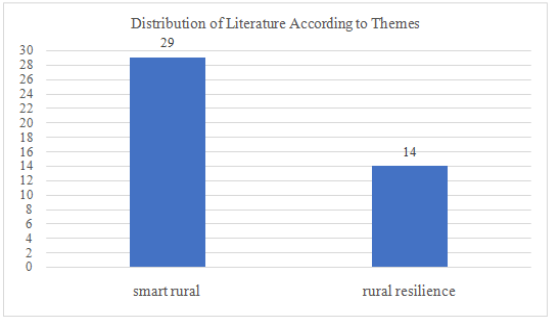


Figure 4: Distribution of Literature by Themes

Figure4 shows that most articles focused on smart rural with 29 publications, while the remaining 14 focused on rural resilience. These publications showed no correlation between the two concepts; however, a common theme was found in the articles: sustainability or sustainable rural development. An example of a study that mentioned sustainability and smart rural was Naldi et al. (2015). They mentioned that the EU started to adopt smartness in its' ten-year growth strategy, Europe 2020, in 2010. This new growth strategy focuses on urban development in the EU and rural areas where smart growth supports sustainable development to achieve regional economic growth (Naldi et al., 2015).

Next, Adamowicz and Zwolinska-Ligaj (2020) also studied smart rural development to attain sustainable development in the EU, specifically in Poland. They found that the smart rural concept can facilitate the sustainable development of rural areas through smart growth (Adamowicz & Zwolinska-Ligaj, 2020). Another study by Anthopoulou et al. (2017) also mentioned rural resilience with sustainable rural development, where the crisis of the agriculture sector in Greece might affect the resilience of the rural areas, thus making it harder to achieve sustainable rural development. This crisis affects rural resilience because agriculture or farming is the main source of income for the rural community in that region (Anthopoulou et al., 2017). In recent studies, Tosida et al. (2024) discussed a smart rural model in pursuinga sustainable economy in the rural areas of Indonesia. This model focused on smart community infrastructure and was validated through the rural areas' economic conditions (Tosida et al. (2024).

Additionally, Ashmore et al. (2015) studied the resilience of rural communities based on their need for fast-speed internet. They found that having superfast internet speed allows the rural communities to use the internet as a personalised tool for skill-building and empowerment, and ultimately results in a sustainable rural community where the rural dwellers have more control over their businesses and enhance individual social connectivity (Ashmore et al., 2015). Furthermore, Chen et al. (2024) studied rural resilience and sustainability through the Geographically Weighted Regression (GWR) model. This model relates resilience with spatial differences of rural settlements and sustainable development (Chen et al., 2024).All 43articlesaddressed the sustainable development of rural areas by mentioning smart rural and rural resilient concepts. However, there is still a lack of past studies that integrate smart rural and rural resilience in the socioeconomic aspect.

Furthermore, some common related topics link the themes together. Table 2 shows the themes and the research context from the reviewed literature. The focus for both smart rural and rural resilience seems to be in the context of rural development with 13 literatures, and with later attention to socio economic context with 7 literatures. This shows that there is still a lack of research regarding socioeconomics in both smart rural and resilience themes. Furthermore, there were other relevant literature that focuses on other research contexts. The research contexts include rural policies, social or rural community, technology, rural planning, aging rural community, rural settlement, disaster management, food security, and rural health.

TABLE 2: RESEARCH CONTEXTS FOR EACH THEME

No.	Author	Theme	Research context
1	Bokun & Nazarko (2023)	Smart rural	Socioeconomics
2	Shcherbina & Gorbenkova (2018)	Smart rural	Rural development
3	Abdul Rashid et al. (2021)	Smart rural	Rural development
4	Hlavăcek et al. (2023)	Smart rural	Rural development
5	Guzal-Dec (2018)	Smart rural	Rural development
6	Fennel et al. (2018)	Smart rural	Rural policies
7	Naldi et al. (2015)	Smart rural	Socioeconomics
8	Wang et al. (2022)	Smart rural	Social aspect of rural community
9	Slee (2019)	Smart rural	Rural policies
10	Srivatsa (2015)	Smart rural	Rural development
11	Gerli et al. (2022)	Smart rural	Rural development
12	Maja et al. (2020)	Smart rural	Rural development
13	Mukti et al. (2022)	Smart rural	Rural development
14	Mukti et al (2022a)	Smart rural	Socioeconomics
15	Aziiza & Susanto (2020)	Smart rural	Technology
16	Adamowicz & Zwolinska-Ligaj (2020)	Smart rural	Socioeconomics
17	Cho & Park (2023)	Smart rural	Social aspect of rural community
18	Zhang & Zhang (2020)	Smart rural	Rural planning
19	Vidmar et al. (2022)	Smart rural	Aging community
20	Sutriadi (2018)	Smart rural	Socioeconomics
21	Kagungan & Rosalia (2022)	Smart rural	Rural development
22	Panciszko (2021)	Smart rural	Rural development
23	Cowie et al. (2020)	Smart rural	Technology
24	Long &Mohad Tazilan (2020)	Smart rural	Socioeconomics
25	Lin & Hou (2023)	Smart rural	Rural development
26	Muhtar et al. (2023)	Smart rural	Rural development
27	Tahir et al. (2016)	Smart rural	Technology
28	Jayawinangun et al. (2024)	Smart rural	Social aspect of rural community
29	Tosida et al. (2024)	Smart rural	Economics
30	Beyene et al. (2023)	Rural resilience	Food security

TABLE 3: RESEARCH CONTEXTS FOR EACH THEME (CONT.)

No.	Author	Theme	Research context
31	Cox & Hamlen (2014)	Rural resilience	Socioeconomics
32	Ashmore et al. (2015)	Rural resilience	Technology
33	Huang et al. (2018)	Rural resilience	Rural policies
34	Anthopoulou et al. (2017)	Rural resilience	Agriculture
35	Jurjonas & Seekamp (2017)	Rural resilience	Coastal rural environment
36	Schouten et al. (2012)	Rural resilience	Rural policies
37	Li et al. (2022)	Rural resilience	Rural development
38	Matsumoto et al. (2008)	Rural resilience	Rural health
39	Yap et al. (2020)	Rural resilience	Technology
40	Rashid et al. (2019)	Rural resilience	Economics
41	Lu & Wu (2024)	Rural resilience	Technology
42	Chen et al. (2024)	Rural resilience	Rural settlement
43	Liu et al. (2024)	Rural resilience	Disaster management

V. REVIEW DISCUSSION

Based on the literature review, it was found that smart rural was widely studied in the years 2020 and 2022 due to the considerable efforts of proposals and projects designed for smart villages in the EUthrough their government initiatives in this period(European Network for Rural Development, 2021). Additionally, smart rural researchwas mainly focused onPoland, Scotland, and the Czech Republic of the EU regions. The literature review shows that the EU can be considered the pioneer for smart rural. However, in Asia, Indonesia has implemented smart rural for years. This country can be a role model for Asian developing nations that are planning to initiate smart rural development plans.

The review of past studies shows a lack of existing knowledge on the linkage between smart rural and rural resilience. However, based on their definitions, both concepts are interrelated by including sustainable rural development. Sustainable rural development was mentioned in smart rural and rural resilience studies in past literature. For instance, Adamowicz and Zwolinska-Ligaj (2020) suggested that smart rural may aid in achieving sustainable development in rural areas of Poland. They found that smart rural initiatives incorporating sustainable rural development showed promising results in less-developed regions in the EU.Another example would be Beyene et al. (2023), who studied the sustainability of the study area and how it reflects food security and rural resilience. The study showed that rural households that could not sustain their resources due to unsustainable rural development were revealed to have poor food security and were non-resilient. Sustainable rural development seems to have an impact towards smart rural and rural resilience and plays a huge role in linking both concepts.

VI. CONCLUSION

Due to limited knowledge of these two concepts, there is still more to study for future research relating to both smart rural and rural resilience. In terms of the socioeconomic aspect of this study, there was also insufficient literature that included this topic with smart rural and rural resilience. Thus, one of the socioeconomic aspects worth considering for future studies is education, as it can be linked with the socioeconomic status of individuals in rural areas. Lastly, future research can delve into a more specific socioeconomic context that is not limited to infrastructure but also in the social aspects, as a number of past works of literature have mentioned that social aspects were more crucial than technological infrastructures in the smart rural concept.

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