

Smart Village and Its Development in Research

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Abstract— The number of smart village development projects increased years by years in countries around the world. Technology and digital innovation have a role in making smart village plan a reality. The main objective of this research is to examine the development of smart villages using technology. The research methodology is consisted of four main phases that is adapted PRISMA. We found n=32 research articles that is used research data. As many five smart village development fields is identified, including energy and water management, tourism, health, agriculture and education. The highest percentage of research number is related to energy management field (34%) and the lowest percentage is health field (3%).

Keywords: *smart village; PRISMA; review; research development*

I. INTRODUCTION

Since 2010, cultural and technological changes have had an effect on changing the way of life and human perspective, especially on the relationship between people, science and technology and creativity. One example of the effect of this change is an increase in the number of smart village development projects in countries around the world. The project addresses the development of rural areas in the form of a clear and structured development road map [1]–[3].

A strategic design in implementing science and technology by relevant stakeholders in rural areas can encourage the use of digital and telecommunications technology for rural communities. This will be a step forward for rural communities to be able to improve and develop business, education and other sectors [1], [4], [5].

Basically, people in rural areas want to explore the potential of their respective villages, such as economy, culture and others. In this case, technology and digital innovation have a role in making this plan a reality. Technology is believed to increase the efficiency and effectiveness of a job. If technology is applied to a village, it will have a positive impact on people's lives. Rural communities can be guided to live by relying on digital technology so that new culture and values will be created in

rural areas. This culture and values will open up opportunities to improve the viability of people's lives for the better [1], [6].

The main objective of this research is to examine the development of smart villages in the world. The main thing that is reviewed from the research on smart villages is the application of technology to support people's lives in the village. The results of this study are expected to become a reference for the community or government who will apply the same concept to their respective environments.

To achieve the main objective of this research, we defined the research questions of this research as follow:

RQ1: What is the smart village development fields?

RQ2: How is the research trend for every smart village development fields?

II. RESEARCH METHODOLOGY

The research methodology is consisted of four main phases that is adapted PRISMA for reviewing scientific articles from Moher et al. in 2005 [7]–[9]. The flow of four phases of this study can be seen in Figure below.



Figure 1. Research phase of this study

The first phase is the identification that means the research database exploration to obtain relevance articles from Google Scholar, *IEEEExplore* and Wiley Online Library, Science Direct and ProQuest. The relevance articles are collected and reviewed to check its eligibility whether it is suitable to answer research questions. After completing all of phases, the final data is presented in Table 1 below.

TABLE I. DATA COLLECTION N=32

Category	Source	N
Agriculture	[10]–[19]	10
Energy Management	[20]–[30]	11
Water Management	[6], [31], [32]	3
Tourism	[4], [33]	2
Education	[34]–[38]	5
Health	[39]	1

III. RESULT AND DISCUSSION

A. Agriculture

In period of 2016-2020, project of smart villages to develop the field of agriculture has been proposed by [10]–[19]. The detailed related studies for smart village of agriculture are presented in Table 2 below.

TABLE II. ARTICLES WITH AGRICULTURE TOPIC N = 10

Author	Type	Source
(Aggarwal et al., 2018)	Journal	[12]
(Jagustović et al., 2019)	Journal	[13]
(Tran, Simelton, & Quinn, 2017)	Journal	[11]
(Maheshwari et al., 2019)	Proceeding	[14]
(Bayala et al., 2016)	Journal	[10]
(Ouédraogo et al., 2019)	Journal	[15]
(Park & Lee, 2019)	Journal	[16]
(Virk et al., 2020)	Proceeding	[19]
(Hellin & Fisher, 2019)	Proceeding	[17]
(Khatri-Chhetri et al., 2019)	Journal	[18]

Bayala et al. (2016) proposed scalable climate-smart village models for agriculture in West Africa [10]. Tran, Simelton, & Quinn (2017) investigated climate-smart agriculture innovations adoption in Vietnam [11]. Moreover, Aggarwal et al. (2018) proposed integrative strategy climate-smart village approach [12].

Jagustović et al. (2019) proposed systems thinking and complex adaptive system for food production management [13]. Maheshwari et al. (2019) developed internet of things for

smart agriculture for handling climatic change [14]. Ouédraogo et al. (2019) investigated adoption rates of climate-smart agricultural technologies [15]. Park & Lee (2019) conducted smart farming projects for rural communities in Korea [16]. Hellin & Fishe (2019) identified transformation of climate-smart agriculture [17]. Khatri et al. (2019) investigated the role of stakeholders in developing climate-smart agriculture [18]. Furthermore, Virk et al., (2020) reviewed the Smart Farming implementation in village [19].

B. Energy Management

In period of 2016-2020, technology development to support energy management has been proposed by [20]–[30]. The detailed related studies are presented in Table below.

TABLE III. ARTICLES WITH ENERGY TOPIC N=11

Author	Type	Source
(Imenes, 2016)	Proceeding	[20]
(Prinsloo et al., 2018)	Journal	[21]
(Prinsloo et al., 2017)	Journal	[23]
(Larsen & Estes, 2019)	Journal	[24]
(Estes, 2019)	Journal	[25]
(Maheshwari & Ramakumar, 2016)	Proceeding	[26]
(Prinsloo et al., 2016)	Proceeding	[27]
(Maheshwari & Ramakumar, 2017)	Journal	[28]
(Duan, Wu, Diao, & Yang, 2018)	Proceeding	[29]
(van Gevelt et al., 2018)	Journal	[30]
(Mehdi et al., 2018)	Proceeding	[22]

Prinsloo et al. (2016) designed community shared solar cogeneration systems using participatory smart-grid control and transactive energy management [27]. Maheshwari & Ramakumar (2016) developed integrated renewable energy systems named SIREs. Moreover, Imenes (2016) conducted research of zero energy homes performance [20]. In 2017, Prinsloo et al. (2017) proposed energy management based off-grid rural community micro-grids [23]. Moreover, Maheshwari & Ramakumar (2016) improved their renewable energy systems named SIREs.

In 2018, Prinsloo et al. (2018) designed micro-grid control strategy using transactive energy management principles and smart-grid multi-agent modelling. Duan et al (2018) developed hybrid solar-hydro micro-grid for school [29]. van Gevelt et al. (2018) proposed strategy for universal energy access in rural communities. In 2019, Larsen & Estes

(2019) proposed sun-blazer IV and smart portable battery kits [24]. Estes (2019) conducted project of Electric Shines Bright in Nigeria [25].

C. Tourism

The research regarding tourism development in village has been proposed by [4], [33]. The detailed related studies are presented in Table 4 below.

TABLE IV. ARTICLES WITH TOURISM TOPIC N=2

Author	Type	Source
(Shen & Wang, 2018)	Proceeding	[4]
(Bahtiar, Segara, & Suyoto, 2020)	Journal	[33]

Shen & Wang (2018) proposed innovation strategies for village tourism development [4]. Moreover, Bahtiar et al (2020) developed smart gamification for Tourism in Indonesian village [33].

D. Water Management

Many researchers have been proposed strategies, models, technologies for managing quality and quantity of water in village [6], [31], [32]. The detailed relevance research for smart village of water management are presented in Table 5 below.

TABLE V. ARTICLES WITH WATER MANAGEMENT TOPIC N=3

Author	Type	Source
(Malche & Maheshwary, 2017)	Proceeding	[31]
(Devadiga, 2020)	Proceeding	[6]
(Manoharan & Rathinasabapathy, 2018)	Proceeding	[32]

Malche & Maheshwary (2017) using internet of things (IoT) for monitoring water level [31]. Moreover, Devadiga (2020) proposed strategies to building smart water communities [6]. Furthermore, Manoharan & Rathinasabapathy (2018) using Lora for metering and monitoring water level in village [32].

E. Education

The research regarding education development in village has been proposed by [34]–[38]. The detailed related studies are presented in Table 6 below.

TABLE VI. ARTICLES WITH EDUCATION TOPIC N=5

Author	Type	Source
(Dey et al., 2017)	Proceeding	[34]
(Malek, 2018)	Journal	[35]
(Faujiah, 2018)	Journal	[36]
(Anderson, 2019)	Journal	[37]
(Kurniawan., et al. 2019)	Journal	[38]

Dey et al. (2017) presented how to use green energy for village school [34]. Malek (2018) presented implementation of Heutagogy education through telecentre [35]. Faujiah (2018) developed model of non-formal education for English language skills in Indonesian village [36]. Anderson (2019) presented Community Empowerment for business education in Smart Village [37]. Moreover, Kurniawan et al. (2019) attempted to expand educational access for Indonesian village communities [38].

F. Health

The research regarding health issues in village has been proposed by [39]. Huang et al (2018) conducted a survey on the status of smart healthcare from the universal village perspective [39]. The detailed related studies are presented in Table 7 below.

TABLE VII. ARTICLES WITH HEALTH TOPIC N=1

Author	Type	Source
(Huang., et al. 2018)	Proceeding	[39]

G. Discussion

Based on research data, we found five smart village development fields, including energy and water management, tourism, health, agriculture and education as depicted in Figure 2 below.

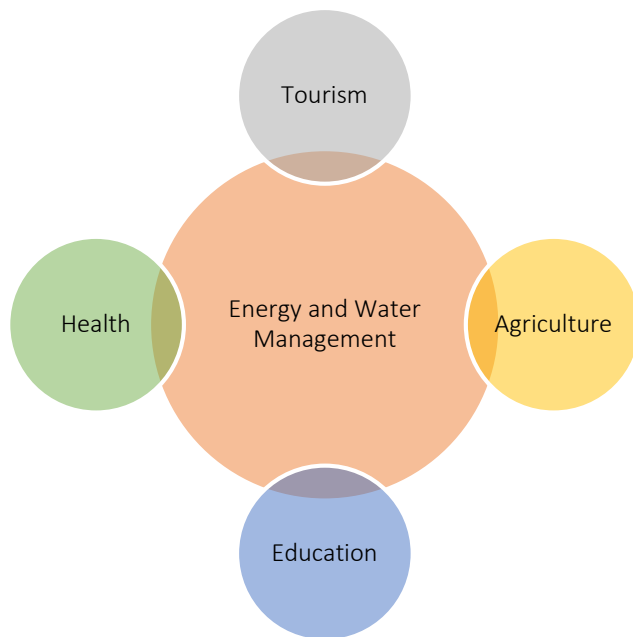


Figure 2. The research field in smart village

The number of studies for every research field is counted into percentage that is depicted in Figure 3. The highest percentage is related to energy management field (34%) and the lowest percentage is health field (3%).

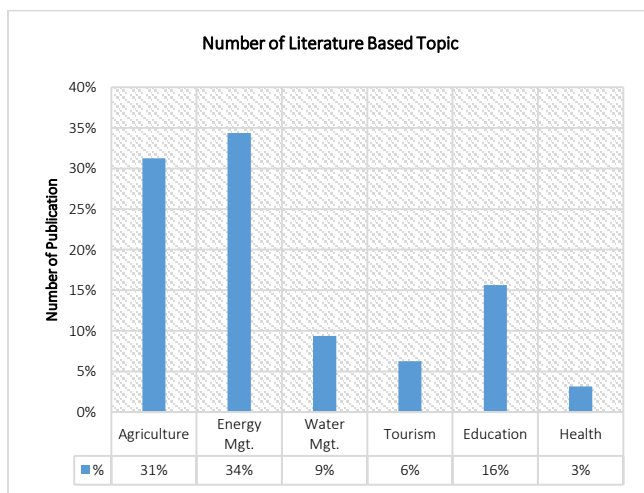


Figure 3. Number of literature of smart village based topic

IV. RESULT AND DISCUSSION

As the result, we identified as many 32 related articles that describes smart village technology in several fields, including agriculture, energy management, tourism, education and health. The statistics of publication number is agriculture

n=10 (31%), energy management n=11 (34%), water management n=3 (9%), tourism n=2 (6%), education n=5 (16%) and health n=1 (3%).

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