

Implementation of Renewable Energy-based Public Wireless Internet Infrastructure in Rural Indonesia

1st Nurchim

Universitas Duta Bangsa Surakarta
Surakarta, Indonesia
nurchim@udb.ac.id

2nd Wijianto

Universitas Duta Bangsa Surakarta
Surakarta, Indonesia
wijianto@udb.ac.id

Abstract— The provision of the internet as an effort to encourage digitalization in rural areas is expected to provide opportunities for rural economic development, employment opportunities, trade, and other conveniences. Implementation of the internet in this rural area is a challenging task especially concerning geographic conditions such as hilly environments, lots of trees, and the location of the nearest broadcast station. Besides, the internet as a public infrastructure in rural areas must be combined with renewable energy to prevent environmental pollution and cost-efficiency. This study aims to analyze the provision of renewable energy-based public internet infrastructure in rural Indonesia using an applied research approach. Public internet infrastructure is developed with a wireless model using solar PV as a source of electrical energy. The results state that the provision of renewable energy-based internet has received a positive response from the village community because it provides easy wireless connectivity. However, there are still a few villagers who use the internet for productive purposes.

Keywords—internet, wireless, renewable energy, rural areas, infrastructure

I. INTRODUCTION

The Internet was a material phenomenon in the twentieth century that necessitated the circulation of energy (electricity, water), the flow of labor, and the installation of technology such as fiber-optic cables and data centers, so the Internet's infrastructure has become a catalyst of urban, economic, and socio-natural change today [1]. The overall beneficial impact of Internet use on users' everyday lives, such as the availability of online content (e.g., music, film, and games), online networking (e.g., email, Wechat, and Facebook), and quick access to varied information and online shopping, which can help to alleviate loneliness, sustain social relationships, and save time and money, respectively [2]. Furthermore, the increasing importance of broadband Internet access as a facilitator of social and economic practices has raised concerns about its efficiency and availability that have broader economic and policy implications than the conventional conception of universal access in terms of the digital divide between rural and urban areas [3]. A Digital Village is a concept that helps developers to reach out to villages that are not yet wired to the internet [4] and it has evolved into one of the supporting infrastructures for the smart village's effective implementation [5].

Indonesia has the most Internet users, but its penetration rate (51%) is lower than the regional average (53%) across Southeast Asian countries especially internet use in rural Indonesia is also restricted due to geographical boundaries and spatial inequalities [6]. According to Statistics Indonesia, the index of ICT growth and another study about digital

innovation in the Java islands (the western part of Indonesia) is higher than in Papua and the Sulawesi islands (the eastern part of Indonesia) [7]. In terms of the development of technologies, the characteristics of rural areas include a lack of basic utilities, such as inadequate electricity, lack of access to socio-economic infrastructure and services, and high system costs, resulting in implementation difficulty [8]. Now, the growth of off-grid solar PV systems, especially in rural areas, would lead to productive uses of renewable energy [9], which can be used to electrify Indonesian rural areas and is on average 3% cheaper than stand-alone diesel gensets [10]. The aims of this study to implementation infrastructure of wireless internet public using solar PV as renewable energy in rural Indonesia.

II. METHOD

As seen in Figure 1, this study was performed using an applied research methodology, which consists of four stages: (1) definition, (2) design, (3) implementation, and (4) reporting. The study will be carried out in Jatisobo Village, Karanganyar, Central Java, Indonesia. According to the village information system, Jatisobo Village has a hilly land layout with an average land height of 265 meters above sea level.

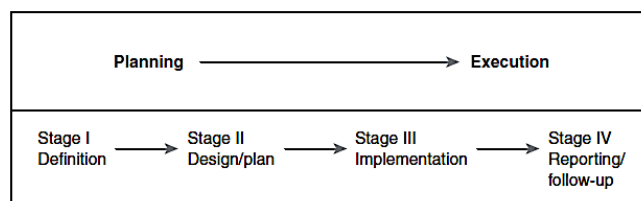


Fig. 1. Applied research approach stages [11]

III. RESULT

A. Definition

The first stage of the analysis process begins with the researcher developing an interpretation of the particular issue, with stakeholders refining and revising study questions to ensure that they can be answered under the research conditions [11]. Geographical conditions [7][11], energy supply [7][12], high costs [13][14] and financial management [16] are all obstacles in building rural internet networks. Furthermore, rural development must understand sustainable characteristics, especially in electrical energy, which is seen as a viable way to eliminate rural energy poverty in an equitable and inclusive manner [17]. Therefore, public broadband internet access would be paired with renewable energy sources.

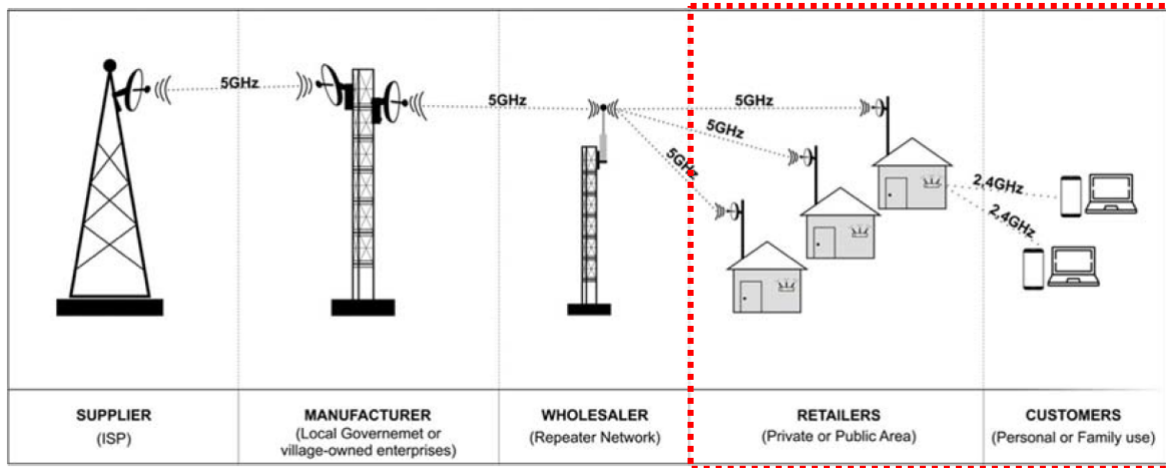


Fig. 2. Wireless internet supply chain approach [4]



(a) Solar PV energy source



(b) Wireless router and wireless access point



(c) Battery storage system and POE switch

Fig. 3. Implementation of renewable energy-based public wireless internet infrastructure

B. Design

One of those attempts from the Indonesian government is to build a fiber-optic backbone network by telecommunication providers with a commercial focus, which will minimize the value of the investment and make rural areas viable areas for business penetration, given the country's vast geography and

form as an archipelago [18]. However, construction difficulties, initial installation costs, fiber cable breaks, and trouble tracing faults have all become issues the fiber-optic network and delivery system [19]. This process makes an architecture acts as a research project's architectural blueprint, connecting design, data gathering, and study tasks to the research questions and ensuring that the whole research

agenda is covered [11]. The supply chain methodology (shown in Figure 2) was used to incorporate the design, which included integrating the internet supply mechanism, internet delivery so that it could be accessed by the village population [4], and this study focused on the interaction between retailers and consumers. Today, wireless networks are becoming more prevalent as we enter the age of digital networks, and the Wi-Fi signal represents at least two concepts: the gateway to the internet world, and a conduit for communicating with others across regional boundaries [20].

C. Implementation

After the design is finished, the next step is to implement the design results in the real environment shown in Figure 3. In certain rural areas, wireless repeater antenna also known as signal boosters can be the most cost-effective way to expand the coverage of fiber optic networks at high speeds [21]. Rural communities can connect to the internet through a wireless access point that supports device-to-device (D2D) communications, which enables users (such as smartphones, tablets, and other mobile devices) to create direct communication links with one another [22]. This is consistent

with rural Indonesia's smartphone adoption rate of 14-24 percent, which is close to the rest of the world [23]. In this proposed study, the use of solar PV for electricity provides a long-term solution for a high-quality electricity source [24].

D. Reporting

In the final stage, the outcomes of the implementation can be tracked via network traffic is very useful for maintenance purposes, and is typically estimated in centralized control, which necessitates a large volume of data to be collected from switches [25]. Many network monitoring systems provide a web interface that allows a human system administrator to manage the application, and sophisticated network monitoring applications can simplify event processing by triggering steps that must be performed when a certain parameter falls below or increases above a certain level in order to maintain the network operational [26]. When it comes to accessing the Internet, Wi-Fi can be a fast and cost-effective solution for wireless clients (WC) [27] which can also be monitored through it. This monitoring is part of the reporting mechanism for the results of the Wireless Internet Infrastructure deployment, as seen in Figure 4.

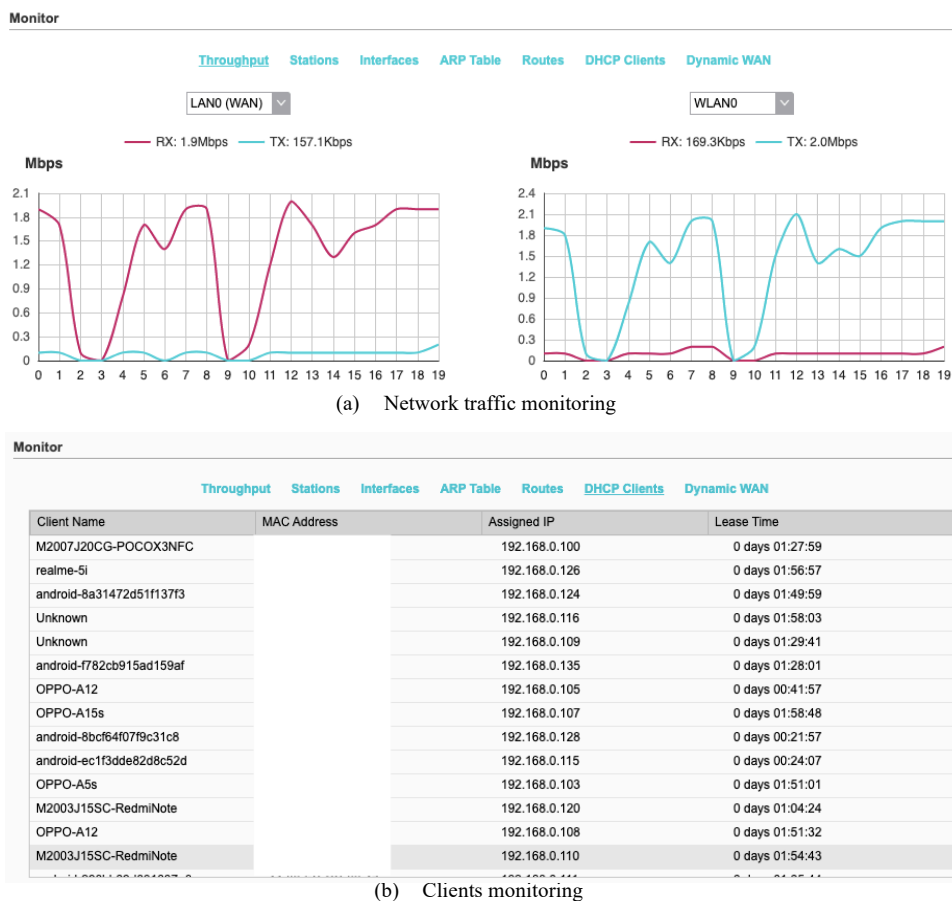


Fig. 4. Monitoring public wireless internet infrastructure

IV. CONCLUSION

Public wireless internet can be alternative technology development, especially information and communication technology in rural areas. Rural communities can easily connect to the internet via smartphones directly to the access point. In addition, this infrastructure development uses renewable sources of electricity so that it can be more cost-effective. Furthermore, monitoring is needed to ensure that the

internet network runs smoothly both in terms of traffic and clients. Finally, rural communities need to be assisted in using the internet for productive activities

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