

## Development of Smart Green City in East Sumba

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### ABSTRACT

This study examines the development of a smart green city in East Sumba Regency through the integration of renewable energy and health digitalization as strategies for achieving inclusive and sustainable urban development. Urbanization in Indonesia has accelerated regional transformation; however, it has also generated development disparities and environmental challenges, particularly outside Java Island. East Sumba faces several critical issues, including limited healthcare accessibility, high infant mortality and stunting rates, and relatively low environmental quality. In response to these challenges, the smart green city concept is proposed as an alternative development model that combines technology-based urban management with environmental sustainability principles. This research employs a qualitative method using a literature review approach. Secondary data were collected from government reports, scientific journals, and relevant publications related to renewable energy and smart green city development over the past five years. The study applies a descriptive-comparative analysis to compare the potential of renewable energy sources, particularly solar power plants (PLTS) and micro-hydropower plants (PLTMH), with conventional carbon-based energy systems. The findings indicate that East Sumba possesses strong potential for renewable energy development due to its high electrification ratio and natural resource availability. In addition, health digitalization is considered essential for improving healthcare services, data integration, and community welfare. Nevertheless, challenges remain in terms of public awareness, infrastructure readiness, stakeholder collaboration, and policy implementation. Therefore, integrated planning, infrastructure development, and continuous monitoring are necessary to support the realization of an inclusive, environmentally friendly, and sustainable smart green city in East Sumba Regency.

**Keywords:** Urbanization, smart green city, inclusivity, East Sumba.

### INTRODUCTION

According to UNDESA (2018), urbanization involves a process of transformation from rural to urban development. This also affects several changes in the sectors of livelihoods, lifestyles, culture, and behavior. However, this process of urbanization is often not inclusive, even causing development gaps in several regions in Indonesia. The Central Statistics Agency (2023) revealed that there is a development disparity between Java Island and outside Java Island. Setiawan et al. (2024) argue that inclusive development is understood as a process that is not only economically beneficial but also

provides equal accessibility for the entire community.

The Central Statistics Agency (2020) revealed that East Nusa Tenggara is projected to experience an average population percentage increase of 26.3% by the year 2035. However, urbanization often has negative impacts on the environment and even on the sustainability of human life. Evtasari et al. (2023) show a predicted economic decline of 18% if global temperatures rise by more than 3°C. The United Nations Framework Convention on Climate Change (2021) also indicates a potential decrease in Indonesia's Gross Domestic Product (GDP) by 3.45% by 2050. Therefore, along with the development of the times accompanied by population growth and economic activities, Indonesia is required to create an alternative development concept that has a sustainable impact and provides good accessibility for the community. Thus, the concept of a smart green city becomes an alternative for better urban development, especially in the Province of East Nusa Tenggara.

The explanation of the smart green city concept starts from the smart city concept, which is defined as the development of a city based on the internet and technology that is integrated among several stakeholders, such as local governments, business actors, and the surrounding community. According to Yim et al. (2015), the study of the smart green city concept prioritizes the principle of nature as a process of circulation and balance in climate change. Therefore, when these two concepts are combined, it can be understood that a smart green city is a concept of city development based on integrated technology that provides balance in climate or environmental change. The implementation of smart green cities has been adopted by several countries in Europe, as outlined in the European Green Index.

European Green Index (2012) divides the green city indicators into several aspects, such as air quality, environmental policy management, energy, transportation, water, and waste disposal systems. The implementation of development in East Sumba adopts several development indicators, such as smart branding, smart economy, smart living, smart society, and smart environment. According to data provided by the East Sumba Regency Government (2023), it was reported that there are two main indicators with a high gap index, namely smart living and smart environment. In the analysis of the Smart Living gap, the health facilities variable is still in poor condition, as indicated by the high infant mortality rate of 88%. Not only the infant mortality rate, but the stunting prevalence indicator is also still at a low index, with a percentage of 14.90% in 2023. Meanwhile, in the analysis of the Smart Environment gap, the environmental protection variable shows that the environmental quality index issue is still at a relatively low figure with a percentage of 61.40%.

By considering the two issues mentioned above, the development of a smart green city based on improving healthcare services and developing environmentally friendly renewable energy becomes an alternative strategy for sustainable smart green city development in East Sumba. These two indicators are very important in supporting the development of a smart green city because they complement each other in enhancing environmentally friendly energy and improving the quality of life for the community. This research will discuss the development of a smart green city in East Sumba by integrating two main development indicators, namely health and renewable energy, to produce an inclusive and sustainable smart green city in East Sumba Regency.

## **METHODS**

This research is qualitative in nature, using a literature review approach to analyze the integration of the renewable energy sector and health digitalization in the development of a smart green city in East Sumba. East Sumba was chosen as the research

object due to its high electrification ratio in the fields of solar energy and micro-hydro energy, as well as its potential for development based on health digitalization.

The data used are secondary data sourced from literature from the East Sumba Regency Government, relevant national and international journals, as well as several articles on the internet discussing the concept of a smart green city in the field of renewable energy over the past five years. The analysis method of this research is descriptive-comparative, aimed at providing a comprehensive detail regarding the potential of solar and wind renewable energy, which is then compared with the use of carbon-based energy. Furthermore, the results of the comparison are expected to serve as policy recommendations for the development of a smart green city in East Sumba.

## **RESULTS AND DISCUSSION**

### **Development of a Smart Green City**

Based on Renewable Energy in East Sumba In general, the development of Sumba Island as an Iconic Island of Renewable Energy is expected to become a pilot project for renewable energy development. The initiative for Sumba Island as an Iconic Renewable Energy Island was presented by a collaboration of the Ministry of Energy and Mineral Resources, Bappenas, and HIVOS (an international NGO from the Netherlands) in 2010, with the main goal of providing 100% renewable energy availability and increasing the electrification ratio to 95% to meet the energy needs of Sumba Island. According to research conducted by the Asian Development Bank (2015), Sumba Island has four renewable energy potentials: micro-hydro, hydro storage, wind-based energy, solar-based energy, and biogas-based energy obtained from animal carcasses and biomass.

The climate of East Sumba Regency is Tropical Savanna. Based on data provided by the Central Statistics Agency (2024), East Sumba Regency has a high level of solar radiation, where from August to October 2024, the highest solar radiation index of the year occurs, with the lowest temperature at 21 degrees Celsius and the highest temperature reaching 34.4 degrees Celsius. In relation to this, the East Sumba Regency area has a Dry Tropical climate. However, the climatic conditions in East Sumba Regency can become a potential, especially as an alternative energy source such as electricity, drinking water needs, and other relevant developments.

From the hydrological aspect, East Sumba Regency is influenced by three types of hydrology, namely unconfined groundwater, confined groundwater, and surface water. Some of the people in East Sumba Regency use shallow groundwater, while others use deep groundwater. In addition, East Sumba Regency also has three categories of rainfall with a semi-arid climate distributed as follows:

1. Low rainfall category, with a capacity of 1,000 mm per year found in the eastern and northern parts of East Sumba Regency;
2. Rainfall category with a capacity range of 1,000 - 1,500 mm per year can be found in the central and southern parts of East Sumba Regency; and
3. High rainfall category above a capacity of 1,500 - 2,000 mm per year found in the western part of East Sumba Regency.

According to Yulianto et al., based on several studies conducted regarding the availability of natural resource-based energy in East Sumba, there is a high availability of solar, water, wind, biogas, and biomass energy. However, according to the data presented,

the energy security index is still considered very low. Yulianto et. al (2019) explain that there are four reasons why East Sumba Regency has a low energy security index:

1. The purchasing power for alternative energy is still low. This is due to the economic conditions of the people in East Sumba Regency, particularly in isolated and decentralized areas.
2. Difficulty in accessing energy, which is still considered challenging for the people of East Sumba due to the topography and suboptimal distribution of areas.
3. Provincial infrastructure limitations
4. The establishment of an institutional-based business model has not yet been formed, as indicated by the statement from the East Sumba Regency government regarding the electrification ratio index in East Sumba, which is only 31%.

The mapping of the vision and mission is produced thru several sub-dimensions of Smart City as the foundation of the smart green city, which is outlined thru Smart Governance, Smart Branding, Smart Economy, Smart Living, Smart Society, and Smart Environment. The development of Smart Green City becomes one of the derivatives of Smart Environment by using the indicator "Energy Management," as the East Sumba Regency Government aspires to realize the development of alternative energy that does not produce pollution, has a level of sustainability, and can reach all layers of society.

As an effort to realize that commitment, East Sumba Regency has developed a master plan for the Energy Management program with the vision of establishing Solar Power Plants (PLTS) and Micro-Hydro Power Plants (PLTMH) in East Sumba, aimed at increasing the use of New Renewable Energy. In this regard, East Sumba Regency aspires to realize the empowerment of solar energy with full utilization of 100% by the year 2033. According to the Quick Wins Smart City of East Sumba Regency, the development of this energy management is targeted to provide progressive development in the utilization of solar power (PLTS) in Matawai Iwi, with the aim of expanding the spectrum of electricity services in the education sector.

In terms of Human Resources, the Central Statistics Agency (2024) reported the Population by Age Group and Gender in East Sumba Regency in 2023, stating that the number of residents entering the productive age (15 – 64 years) was 158,177 residents. The analysis of Human Resource (HR) readiness is conducted to measure the capabilities of the local community and implement the smart green city concept. Human Resources (HR) are an important indicator in the implementation of this smart green city because the community will be both the executors and the beneficiaries of the program's implementation. If there is a good readiness index, then preparations for programs aimed at improving the community in East Sumba Regency will be carried out.

In terms of governance, the analysis of national resource readiness is defined as an indicator for the assessment of local government in the implementation of the smart green city program. It was stated that East Sumba Regency consists of many regional officials with the highest education levels being bachelor's, master's, and doctoral degrees. Looking at the results of the analysis above, the readiness of Human Resources (HR) is an important indicator in the development of a smart green city in East Sumba. The East Sumba Regency Government (2024) stated that out of the total number of civil servants with master's degrees, there are 67 individuals, with a note on the addition of human resources with backgrounds in Information Technology (IT) to support the smart green city program.

According to Gultom et al. (2020), Micro Hydro and Solar energy types rank third and fifth as Energy Potential in Indonesia, with availability reaching 19,385 MW and 207,898

MW. According to him, the potential for renewable energy consisting of solar, wind, wave, and geothermal in Indonesia is considered a small spectrum of the energy mix, but some of these are continuously developing. One of the solar power plant developments in East Nusa Tenggara is the Oelpuah solar power plant developed by PT LEN Industri, located in Kupang, East Nusa Tenggara, with a capacity of 5 MW. Given this, the construction of this solar power plant can certainly serve as a model project for the development of solar power plants in East Sumba Regency. Based on the aforementioned legal frameworks, several strategic steps have been taken by the government in the implementation of a smart green city on Sumba Island, particularly in East Sumba.

By examining the geographical and climatic analysis supported by the Human Resource analysis and the vision and mission of East Sumba Regency, the development of solar power plants in East Sumba Regency becomes one of the potentials for building a smart green city in the renewable energy sector. According to PT PLN Sumba Timur Customer Service Unit, Sumba Timur Regency has an electrification ratio of 99% with a composition of 77 percent from 140 villages and 12 sub-districts located in 22 districts with a total of 45,000 customers in Sumba Timur Regency. Satu Data Indonesia (2024) defines the electrification ratio (RE) as an index comparing the number of household customers (PLN electricity and non-PLN electricity) with the total number of households.

The utilization of renewable energy sources derived from alternative energy sources is also conveyed in Presidential Regulation Number 22 of 2017 concerning the National Energy General Plan, which outlines the Government's commitment to increasing the capacity of solar power plants (PLTS) and micro-hydro power plants (PLTMH) to 14.4% and 6.6% by 2025. It was stated that the electrification ratio in East Sumba is part of the National program to reduce energy disparities throughout Indonesia. Lomi et al. (2016) also added that East Sumba Regency has the highest electrification ratio compared to the other three regencies.]

PLTS can be used as an alternative renewable energy source to be applied in East Sumba Regency. Not only because of the adequate electrification ratio as the main factor for the installation of solar power plants, but also due to the accessibility of sunlight that can be reached in every sub-district and village in East Sumba. According to Praing (2023), due to the very vast geography of Sumba Regency, the limited condition of infrastructure accessibility has become one of the main factors contributing to the infrastructure gap in East Sumba Regency. In 2024, 39.63% of the roads in East Sumba Regency were in good condition, 43.47% were in severely damaged condition, and 56% were already paved. In addition, it was found that many areas in East Sumba Regency still fall into the "blank spot" category (areas not covered by communication signals). This is also due to inadequate infrastructure, especially in some areas.

The potential of solar power plants (PLTS) as a good alternative renewable energy source can also be seen in the efficiency of PLTS usage, not only in regional infrastructure but also in households, which is expected to reduce the cost of carbon-based electricity usage and save on electricity bills. According to a study conducted by several sources, it was reported that solar power plants (PLTS) have a technical efficiency level reaching 18 - 23%, providing an economic efficiency of USD 0.06/kWh and also not contributing to pollution in the environment. As for the projection of PLTS efficiency, it is estimated that by 2025, PLTS can provide a module efficiency of 21%, with projections for 2030 and 2035 showing increases of 25% and 28%, respectively. According to Rifaldi et al. (2023), solar energy is considered a promising prospect for renewable energy utilization due to its clean and sustainable energy source.

Several solar power plant constructions in East Sumba Regency have been carried out by PT Surya Energi Indotama (2021) aimed at lighting up 909 houses in remote areas

along 48 Km with limited land utilization. This development includes 11 systems in five villages, namely Tawui Village, Lailunggi Village, Praimadita Village, Tandula Jangga Village, and Praiwitu Village, from September 2017 to March 2018. This development is driven by the inaccessibility of electricity supply in several isolated areas, providing a relatively affordable cost recommendation for rural communities compared to using fossil fuels. During the construction period, PT Surya Energi Indonesia involved BumDes in the installation process thru training on how to operate and maintain solar power plants, which subsequently made the community the majority shareholders with a percentage of 51%.

According to Meheng et al. (2017), the development of solar power plants (PLTS) has also occurred in Ngadu Ngala District, East Sumba Regency. This development is driven by the abundance of renewable energy sources that can be developed, namely PLTD, PLTB, and PLMTH. Therefore, Meheng et al. (2017) conducted a planning study by calculating the forecast electricity load using the Linear Regression method.

It was reported in the research findings that there was a historical increase in daily energy consumption forecasted from 2015 to 2024 by 159.16%, with total consumption data of 1,089 kWh per day. From the research results, it was stated that the appropriate use of solar power plants (PLTS) adopts a hybrid PLTS system with diesel power plants (PLTD) for a load forecast of six hours per day over the next 10 years. The combination of these two alternative energies is carried out with consideration of energy use efficiency as well as load calculation results and the reliability of the hybrid solar power plant with diesel generator (if the diesel generator cannot produce electricity, there is still production from the solar power plant with a capacity of 14%).

The construction of solar power plants also took place in Kalamba Village, East Sumba Regency, with the introduction of a technological innovation called SuperSUN (Surya Power Solution for the Nation) on July 17, 2025. This project is a collaboration between the PLN Sumba Electricity Project Implementation Unit (PLN UP2K) and the Research and Development Center, aimed at providing clean and affordable energy for communities in remote areas. General Manager of PLN UIW NTT, Mr. F. Eko Sulistyono, revealed that one of the advantages of SuperSUN is the monitoring of electricity usage online thru smartphones, allowing for 24-hour monitoring.

Beside solar power plants, Micro Hydro Power Plants have become one of the renewable alternative energies that can be implemented in East Sumba Regency. One of the installations of Micro Hydro Power Plants (PLTMH) took place in Nggongi Village, East Sumba Regency, with the background of a Diesel Power Plant (PLTD) with a capacity of 5kW operating only for 12 hours from 18:00 to 06:00 WITA. According to Likadja et al. (2022), it was reported that the number of households reached 495 households, with a composition of 236 households being PLN electricity customers and 259 households being non-PLN customers. Along with the continuous growth of the population and the economy, alternative electricity sources are needed that can be used as one of the power sources to meet the electricity demand of the people of Nggongi Village and its surroundings thru micro-hydropower plants (PLTMH) utilizing the potential of the Pahambur Wai river for PLTMH.

Likadja et al. (2022) also projected the revenue from the operation of PLTMH with a selling price of electricity set at Rp. 741/kWh with a tariff escalation factor of 4% per year. This revenue projection is derived from the comparison of the operational costs of PLTH with other power plants such as PLTD, resulting in an estimated amount of Rp.

21,335,754,825.41 over 25 years, thus saving operational costs of Rp. 23,76,394,250.45. According to the analysis of the above revenue projection, it can be understood that the use of alternative renewable energy such as PLTS and PLTMH can yield a high level of efficiency in terms of usage and projected revenue, especially from the aspect of Regional Revenue.

The Central Statistics Agency of East Sumba Regency (2023) presented information regarding the Revenue of the East Sumba Regency Government in 2023. It was stated that the Other PAD sector, which includes investment income from renewable energy, occupies the highest position in terms of percentage. It can be understood that since the construction of solar power plants (PLTS) and micro-hydropower plants (PLTMH) in East Sumba Regency, there has been an increase in regional revenue from other PAD sectors. This statement is also reinforced by UNDP Indonesia, which revealed that the development of renewable energy (solar power plants and micro-hydropower plants) has the potential to boost the local economy, with income ranging from Rp. 1,500,000 to Rp. 11,600,000.

As explained in the previous paragraph regarding the potential for renewable energy development in East Sumba Regency along with the prospects of development on the regional revenue ratio, efficiency of electricity expenditure, and efficiency in energy use compared to carbon-based energy, the discussion on renewable energy business models consisting of solar power plants (PLTS) and micro-hydropower plants (PLTMH) in East Sumba Regency becomes one of the important discussion topics to measure the sustainability level of renewable energy development in East Sumba Regency. Based on data provided by SASK Energi (2020) regarding the distribution of PLTS and PLTMH development in East Sumba Regency, several data points are presented as follows:

#### A. List of Solar Power Plant Development Distribution in East Sumba Regency

No.	Power Plant Name	Developer Name	Location	Capacity
1	PLTS Hambapraing	PT Buana Energi Surya Pers	Sumba Timur	1 kWp
2	PLTS Ngadu Ngala	PT PLN	Kecamatan Ngadu Ngala, Kabupaten Sumba Timur	4 kWp
3	PLTS Sumba Timur	PT Surya Energi Indotama	Tawui, Lailunggi, Praimadita, Tandula Jangga, dan Praiwitu.	492 kWp
4	PLTS Kalamba	PT PLN & Puslitbang	Desa Kalamba, Kabupaten Sumba Timur	N/A

Sumber: SASK Energy Project for Indonesia, Website PT Surya Energi Indotama, dan Website RRI Provinsi NTT

#### B. List of the Distribution of Micro-Hydro Power Plant Development in East Sumba Regency

No.	Power Plant Name	Developer Name	Location	Capacity
1	PLTMH Nggonggi	N/A	Desa Nggonggi, Kabupaten Sumba Timur	128 kWp
2	PLTMH Wairara	Mahu BUMDes Wairara	Desa Wairara	128 kWp

Sumber: SASK Energy Project for Indonesia dan Website RRI Provinsi NTT

By analyzing the distribution of solar power plants (PLTS) and micro-hydropower plants (PLTMH), it can be understood that on average, the development of renewable energy involves the private sector as the developers in the management of renewable energy, with only one PLTMH involving the Wairara Village-Owned Enterprise (BUMDes) as the developer of the PLTMH energy. Yulianto et al. (2020) developed research based on a business model with an emphasis on cooperation between the private sector and the government. From the research findings, it was discovered that renewable energy development in East Sumba Regency adopts Public Private Partnership as a form of cooperation arising from the desire to improve public services and address social issues initiated by the government and built by the private sector. According to them, PPP should be evident in the overall development of the public sector, which is then referred to as New Public Management, consisting of government decentralization, separate accountability in public service procurement, measurement of public service performance, contract services in the private sector, and privatization of public services.

Yulianto et. al (2020) also added that development involving the government has six main issues, including: 1. Weak policies regulating the role of the private sector in renewable energy development. 2. Unclear bargaining positions of the private sector. 3. Renewable energy development in collaboration with the private sector and government requires a high level of cooperation. 4. Lack of good coordination between the government and the private sector. 5. Lack of transparency in the collaboration between the private sector and the government. 6. Discussions regarding solutions to the problems are considered ineffective.

Yulianto et. al (2020) also argue that in order for energy development to proceed well, it is necessary to create an investment climate and easy policy regulations, particularly in strengthening the role of the government with the private sector in the development of renewable energy in East Sumba Regency. The development of an investment climate reputation is also recommended to establish a one-stop service as a form of centralized public service in East Sumba Regency. In addition, the development of renewable energy also needs to be supported by several parties, including the Ministry of Energy and Mineral Resources, the Department of Energy and Mineral Resources of East Nusa Tenggara, the East Sumba Regency Development Planning Agency, the East Sumba Regency Research and Development

Agency, the Financial Agency, BUMDES, NGOs, and PLN Sumba. The results of the research also reveal that each party has its own role in the development of renewable energy in East Sumba Regency, which includes: 1. Development of infrastructure accessibility 2. Provision of technology and facility infrastructure 3. Energy efficiency use by the community 4. Knowledge transfer thru education and training 5. Improvement of renewable energy distribution 6. Empowerment of human resources 7. Ease of investment 8. The need for policies that support private sector participation 9. Support

from financial institutions 10. Education 11. Capital investment support for energy provision

However, despite the achievements made by East Sumba Regency in the development of a smart green city, many people are still unaware of the potential for renewable energy development in East Sumba. This poses an obstacle to the development of renewable energy in East Sumba, particularly in creating an investment climate and increasing the level of self-sufficiency of the East Sumba community in managing renewable energy in East Sumba. Yulianto et al. (2020) also revealed that although the demand is high, it has not yet generated interest from the community because the focus of the purchasing mindset of the East Sumba community is only centralized on the superior value of a product, which provides benefits to the community's life. Secondly, the development of alternative energy has not necessarily been considered a beneficial commodity. Thirdly, the tendency of the East Sumba community in purchasing decisions is based on high value. Considering the above, a quick wins mechanism is needed for the development of a smart green city based on renewable energy.

Considering the achievements, opportunities, and challenges in the development of a smart green city in East Sumba Regency, a planning mechanism is certainly needed for the development of the renewable energy sector in East Sumba Regency, as a priority support for smart city development, including: 1. Development of Product Marketing Strategies Yulianto et al. (2020) explain several alternative product marketing strategies thru Value Creation by combining two types of strategies, namely Resource Based Strategy and Market Based Strategy. This combination is made to accommodate the purchasing characteristics of the East Sumba community in their product purchasing decisions. Additionally, the combination of these two types of marketing strategies is also based on the aspect of resource-based development strategies, which are considered less capable of accommodating the market characteristics of the East Sumba community.

Maulana et al. (2016) provided information on how the resource-based strategy and market-based strategy approaches are used in marketing strategy management. The differences between these two types of marketing strategies are as follows:

No.	Indikator	Market Strategy	Based Resource Strategy	Based
1	Sumber pengembangan	Ketertarikan terhadap pasar	Sumber daya yang tersedia	
2	Jenis Pengembangan	Berdasarkan nilai kompetitif	Kapabilitas organisasi yang mengolah sumber daya	
3	Jenis Strategi	Umum	Spesifik, karena sumber daya harus bersifat unik	
4	Manfaat	Kompetitif	Kompetitif	
5	Hasil Strategi	Strategi Kompetitif	Strategi Kompetitif	

From the comparison of the two types of marketing strategies, Yulianto et al. (2020) also added that in the development of renewable energy, market targeting is necessary to support the renewable energy development business in East Sumba. In terms of type, market segmentation is divided into four main segments, which include the

public, private companies, state-owned enterprises (BUMN), and government agencies. Each segment requires a different approach, making it essential for companies or the private sector to continuously innovate, not only in terms of quality but also in pricing. Therefore, the planning of renewable energy development for solar power plants (PLTS) and micro-hydropower plants (PLTMH) needs to be comprehensively planned in terms of both technical and technological aspects. The planning requires calculations of the electrical energy produced by the PLTS.

### **Development of Local Management Capacity**

Based on the previous table regarding the distribution data of solar power plants (PLTS) and micro-hydropower plants (PLTMH) in East Sumba Regency, the private sector still has full control over the operation of renewable energy in East Sumba. Of course, on one hand, this still remains a task for the East Sumba Regency government to improve human resources. This is done to support energy self-sufficiency, particularly in human resource management in East Sumba. Although the existence of renewable energy management operated by private companies can create knowledge transfer, it does not necessarily result in sustainable long-term effects. Therefore, it is expected that the number of human resources involved comes from the surrounding community for the knowledge transfer process.

In addition to the government and private companies, the existence of vocational training institutions has become one of the important indicators in creating human resource performance standards in East Sumba Regency. It is hoped that with the creation of balanced job opportunities, the number of open unemployment will decrease, and the economy will grow progressively. Therefore, the government, as the main gateway in the creation of optimal job opportunities, is expected to provide alternative solutions for the surrounding community to support the inclusive and sustainable Smart Green City development program in East Sumba Regency.

### **Potential Development of a Smart Green City Based on Health Digitalization in East Sumba**

- a. Overview of Health Digitalization Development in East Sumba Based on the East Sumba Regency Government document, there are at least three main pillars of health digitalization development in East Sumba:
  - a. Clarification of Regional Smart City Policy (Quick Wins Smart Living)
  - b. Web-based health service registration innovation at the Regional General Hospital (SIBERWEB).
  - c. Drug inventory information system at the Health Office (SITEPAT).

These three elements reflect that East Sumba has entered the early phase of health digitalization, although it is still focused on administrative functions and logistics management and has not yet fully touched on clinical integration, large-scale telemedicine, or cross-sector data analytics. In the Quick Wins Smart City Document of East Sumba Regency, SIBERWEB at Umbu Rara Meha Hospital is described as an innovation that provides web-based access to information and health services. The community can register online, reducing waiting times and crowds, and obtaining service information more easily.

#### **1. Conceptually,**

The Quick Wins program shows that local governments have recognized the importance of health digitalization as part of a Smart City.

a. SIBERWEB: Digitalization of Hospital Front Office Services The web-based registration system developed by RSUD Umbu Rara Meha Waingapu is a concrete example of digital transformation at the forefront of healthcare services. This system allows patients to register online before coming to the hospital, thereby reducing physical queues at the registration counter, speeding up the patient administration process, and providing convenience for patients in choosing the polyclinic and visit schedule.

From the perspective of a Smart Green City, the development of SIBERWEB has the potential to support the efficient use of resources (time, paper, and energy) thru the reduction of manual processes and physical archives, the decrease of congestion and crowding in healthcare facilities that impact environmental quality, and the utilization of visit data and patient profiles for city health planning, including the development of new facilities, public transportation to hospitals, and health-friendly spatial planning. However, this efficiency depends on the ability of SIBERWEB to integrate with other information systems, such as electronic medical records and JKN claim reports, as well as expanding access to patients from various backgrounds, including those living in villages with limited internet access.

In the Quick Wins document, it is mentioned that SIBERWEB serves as a platform for the community to access inclusive health information and services, indicating that the application's role is not only administrative but also as a channel for public health communication and education. If further developed, SIBERWEB can be integrated with health promotion content, disease surveillance, and community-based health complaint reporting in line with the WHO Healthy Cities guidelines, which emphasize community participation and local data for regional health planning.

b. SITEPAT: Digitalization of Pharmaceutical Logistics for Efficiency and Sustainability

Another important innovation is SITEPAT (Drug Inventory Information System of the East Sumba District Health Office). This system is designed to monitor the availability of medicines and health equipment in various healthcare facilities, thereby accelerating the reporting of drug stocks from community health centers to the Health Office, facilitating the analysis of drug needs and proper distribution, and reducing the risk of stock shortages or excesses that could lead to the expiration of medicines or health equipment. SITEPAT contributes to the efficiency of pharmaceutical logistics, which is very important in the context of areas with limited transportation access. In the perspective of a Smart Green City, more efficient logistics management has the potential to reduce the frequency of trips and emissions associated with drug distribution.

## **2. Infrastructure readiness analysis**

The development of a Smart Green City based on health digitization in East Sumba Regency heavily relies on the readiness and availability of basic infrastructure, both physical and information technology. East Sumba, as an island region, has challenging geographical conditions with a relatively large population distribution and many villages that still do not have access to internet services or even stable electricity. This situation affects the region's readiness to implement health digitalization.

The geographical conditions of East Sumba Regency are one of the success parameters in the development of a Smart Green City, with the aim of improving the quality of life of

the community thru resource efficiency and digital innovation. Based on the report from the Central Statistics Agency of East Nusa Tenggara Province (2024), it is mentioned that 153 villages have been installed with 4G/LTE networks in East Sumba Regency, followed by 26 villages still equipped with 3G/H/H+ networks, and 16 villages still having 2G/E/GPRS networks. Additionally, data from the East Sumba Communication and Information Office (2024) explains that the 4G internet coverage includes 78% of the urban area of Waingapu and only 43% in rural areas. Therefore, this disparity has implications for the distribution of access to information regarding digital services, including data-based health services. However, despite the infrastructure disparity, the development of new Base Transceiver Station (BTS) installations in several sub-districts, as well as the Digital Village initiative and the Sub-district Internet Service Center (PLIK), signal progress in digital readiness in East Sumba Regency.

In the Quick Wins Smart City Document of East Sumba Regency, it is emphasized that one of the main challenges in developing smart health services is the availability of internet networks in rural areas and the limited tools/facilities to access digital services. In the risk section of Quick Win Smart Living, it is mentioned that communities in rural areas who need digital health services are often hindered by network and device limitations.

This condition is in line with the findings of several studies on the digital transformation of health services in Indonesia, which show that the eastern regions of Indonesia and 3T areas generally have more limited forms of digital transformation compared to other regions, both in terms of the coverage of health applications, health information systems, and digital help desk services. This indicates that regionally, East Nusa Tenggara, including East Sumba, falls into the lower-middle category in terms of ICT infrastructure readiness to support integrated digital health services.

From the national policy perspective, the development of digital infrastructure has actually been encouraged thru various programs, including the expansion of broadband networks, the Palapa Ring, as well as the implementation of SPBE and Smart City in the regions. However, at the district level, the gap between macro policies and micro readiness (village, community health center, and household levels) is still quite significant. This means that for the initial implementation of a health-based Smart Green City, more focus should be directed toward strengthening the foundations of connectivity (internet access, devices, local data centers, and operator training).

### **3. Analysis of Health Infrastructure and Information Systems**

Health issues are one of the priority developments of the East Sumba Regency Government, as explained in the NTT Provincial RPJMD. Although East Sumba has the highest number of nursing and medical staff, it seems that the people of East Sumba have not yet felt the direct positive impact regarding healthcare services in East Sumba. This is reinforced by the high disparity in infant mortality, maternal mortality, and rural transportation service indicators. In relation to this, in order to bridge some of the existing conditions, a health digitalization strategy becomes one of the solutions that can be applied in the development of a smart green city. It is hoped that this health digitalization will not only reduce the health disparity but also provide direct benefits to the people of East Sumba.

The design of the digital health business model can be applied thru a digital circular economy model approach, prioritizing collaboration between the public, private, and community sectors. This design aims to add economic value thru the utilization of data, environmentally friendly technology, and social innovation to enhance digital-based healthcare services. The development of digitalization in the health sector is not only

beneficial for human life but also has a good sustainability index for life in the form of waste reduction, resource efficiency, and recycling systems in the healthcare service system.

Referring to the urgency of the aforementioned healthcare service transformation, here are some recommendations for health digitalization that can be implemented in East Sumba Regency, thru several technological developments such as:

- a. The existence of teleconsultation with healthcare professionals, especially for patients who face accessibility barriers between their homes and the nearest healthcare facilities. This is also beneficial for medical personnel to improve travel time efficiency to the patient's location, allowing patient care decisions to be made based on priority levels.
- b. Initiation of the use of e-prescription and e-medical records aimed at reducing operational costs associated with paper usage, thereby saving the hospital's operational budget.
- c. Operation of a digital inventory system to manage the retention of used medical equipment, thereby reducing the amount of medical waste that directly impacts the healthcare sector. This system also functions to monitor waste volume for the management of recycling processes and the efficiency of medical waste transportation.

From the perspective of health infrastructure, East Sumba already has a network of services including regional hospitals, community health centers, and other basic service networks. The readiness of digital infrastructure is evident from the emergence of innovations such as:

SIBERWEB at RSUD Rara Meha, which is a web-based patient registration system that makes it easier for the community to register online. This system was developed as a continuation of the existing online registration and is equipped with technical guidance for healthcare personnel.

SITEPAT (Drug Inventory Information System) at the East Sumba District Health Office, which accelerates the reporting and monitoring of pharmaceutical supplies digitally.

Both innovations show that some elements of digital health infrastructure have already been established: servers or web services are available, internal networks are in place, and human resources are becoming accustomed to operating information systems. If compared to the standards of literature on digital health in smart cities, which emphasize the importance of electronic medical records, hospital management systems, telemedicine, and integration with urban data platforms, East Sumba can be said to be at an early stage where the focus on digitizing administrative and logistic processes has not yet fully transitioned to clinical integration and overall health data analytics. Therefore, significant investment is still needed in aspects of connectivity, information system integration, and strengthening human resource capacity before being able to implement more advanced smart health services (telemonitoring, IoT integration, and health big data analytics).

#### 4. Health Digitalization in Smart Green City In the Smart City paradigm.

The health sector is usually placed in the smart living cluster, which emphasizes improving the quality of life for residents thru the use of information and communication technology (ICT) in health, safety, and welfare services. Health digitization includes the

utilization of e-health, m-health, electronic medical records, telemedicine, hospital management information systems, and the integration of health data into government big data.

In this context, East Sumba Regency has the opportunity to position health digitalization as a key driver of transformation toward a Smart Green City by utilizing ICT to expand access to health services in challenging island regions, while also integrating health data with environmental information, spatial planning, and energy use. In the context of East Sumba, health digitalization is not only about service efficiency but also a means to overcome geographical limitations and physical infrastructure, allowing health services to reach remote areas in a more practical way.

The development of health digitization mentioned above requires several recommendations for business development strategies based on smart green city principles, which include three main pillars, namely:

- a. Collaboration between the government, private sector, and community in the development of health digitization. The government acts as a regulator and provider of facilities, the private sector as the executor of technological innovations, and the community as users and managers of health data. Of course, this collaboration will provide benefits in the financial and social sustainability of the health digitalization project.
- b. Implementation of the Green Investment  
Mechanism by prioritizing the use of energy-efficient medical devices as the main component of the green business chain. According to Du et al. (2019), the development of green investment has a significant impact on the advancement of environmental improvement. Additionally, the adoption of green investment can also have a direct impact on the political and economic fields. Dai et. al (2016) also emphasized that the development of green investment can reduce CO2 emissions and air pollution. When contextualized to East Sumba Regency, the implementation of this green investment will certainly have a significant positive impact on the development of a smart green city, particularly in enhancing green infrastructure that can provide sustainability for the community.
- c. The digitization of health data thru Electronic Health Records, which serves to enhance healthcare services for patients, also functions as an efficiency in the operational expenditures of healthcare facilities. Cowie et al. (2017) state that Electronic Health Records assist in supporting observational research, integrated with primary research data or other datasets. In clinical research studies, Electronic Health Records also serve the function of reducing data duplication, thereby lowering operational budgets in the field of data administration. The reduction in operational use of technology equipment in data administration can also decrease environmental pollution levels, which can benefit human survival.

## 5. Challenges in the development of a smart green city based on health digitization in East Sumba

In addition to the potential for health digitization that can be developed in East Sumba, further analysis is needed regarding the challenges faced in the development of health digitization in East Sumba. East Sumba is currently facing a number of multidimensional challenges in the technical, social, policy, and digital culture fields. These challenges are reflected in several indicators, including:

a. The gap in infrastructure and digital development

The concept of infrastructure development not only includes the construction of public facilities but also the existence of Human Resources as one of the infrastructure aspects in the digital health services in East Sumba. To support the synergy of coordination between agencies, the existence of health digitalization is necessary as a primary indicator in cross-sector coordination. In addition, data centralization is also necessary as a key supporting component to prevent information duplication and a decrease in decision-making efficiency. According to Hasibuan (2009), there are four main functions in coordination, namely:

1. As an effort to achieve a specific goal, so that the work carried out aligns with the objectives and targets to be achieved.
2. To enhance individual skills toward a specific goal, to support the organization in achieving the company's vision and mission.
3. To reduce the duplication of job roles so that the organization operates more effectively.
4. To organize work units according to the tasks and functions of each organization.

b. Social retention and digital literacy

The disparity in digital infrastructure in East Sumba has led to low levels of digital literacy, particularly among the elderly and rural communities. Most of the reluctance to use digital services is due to distrust in the security of personal data in online systems.

c. Funding and financial sustainability

The development of health digitalization requires a very high initial investment cost. The poverty index and fiscal constraints are among the obstacles in the development of a smart green city in East Sumba. Therefore, the existence of strategic partnerships and several green financing innovations has become one of the main drivers in improving health digitalization services in East Sumba.

d. The influence of social structure on the accessibility of assets and the right to develop personal competencies.

The existence of social structures in East Sumba has become one of the significant challenges that greatly affect the development of the smart green city in East Sumba. Putra (2019) conducted research on social differentiation based on status and roles in East Sumba. From the research, it was found that this differentiation of social status has been occurring for a very long time and has a very high level of patriarchy, as it is believed to be a belief and has been passed down thru generations. In the research, it was stated that there are three social statuses in East Sumba, namely marimba, kabihu, and ata. Maramba is a social status that receives privileges and power in asset ownership, honor, the right to express aspirations, and resource management. Second, kabihu is referred to as ordinary people (without privileges in that social status), and ata is referred to as servants.

Dharma (2019) also adds that for the Maramba caste, there are four major roles performed by that social status, namely as family leaders, customary leaders, heads of security, and religious leaders. In Maramba itself, there are high levels, namely Maramba Bokulu (high nobility), Maramba Mendamu (the child of a marriage between a Maramba man and a Kabihu woman), and Maramba Kalawih (the child of a marriage between a Maramba man and an Ata woman). Each of these three divisions of Maramba has a second class, namely Kabihu, which is considered the common people's class divided into two

types, namely Kabihu Bokulu (someone who has a central role in customs) and Kabihu Kudu (who does not have the same role as Kabihu Bokulu). Next, the Ata class becomes the third class, divided into two levels, namely Ata Bokulu (Ata who has been inherited) and Ata Kudu (people who were previously not part of the Uma members of Maramba), in other words, Ata is a slave or servant.

As a result of this, it has affected the Human Development Index in East Sumba Regency. According to the Central Statistics Agency of East Sumba Regency (2024), based on the Human Development Index data by gender published from 2020 to 2023, it was reported that there was an average increase in the Human Development Index for males by 0.7% and for females by 1.34%. If these figures are accumulated and compared with other provinces, this certainly becomes a matter of concern for the government in improving the Human Development Index in NTT Province, especially in East Sumba Regency.

## **CONCLUSIONS**

The development of a smart green city based on renewable energy and health digitalization certainly requires several strong main and supporting indicators, starting from the planning and implementation stages. At the planning stage, the existence of a master plan becomes one of the important points in development planning, which contains the vision and mission of East Sumba as well as the development direction of East Sumba Regency. At the development stage, the role of stakeholders also becomes one of the main indicators that are very important in determining the direction of development and program execution. Beside stakeholders, the existence of infrastructure readiness and geographical aspects are key points in the implementation of development, as they serve as supporting facilities for development to attract an investment climate in East Sumba. At the completion stage, the function of monitoring and evaluation becomes a benchmark for the efficiency and effectiveness of the smart green city development in East Sumba Regency.

In the renewable energy sector, the existence of solar power plants (PLTS) and micro-hydropower plants (PLTMH) has become one of the alternative solutions for developing environmentally friendly energy. This is due to the high electrification ratio potential in East Sumba, which has a positive impact on the development of solar power plants (PLTS) and micro-hydropower plants (PLTMH) in East Sumba. As a result, many areas in East Sumba have already built PLTS and PLTMH. However, the community still does not understand the importance of PLTS and PLTMH energy in daily life. Beside their environmentally friendly nature, PLTS and PLTMH have not yet received good enthusiasm from the local community. This is due to the social and economic conditions of the people in East Sumba, which leads them to prioritize the purchase of goods that have an efficient and low value. This is certainly a matter of concern for the government in creating installation programs or purchasing renewable energy support units so that they can be comprehensive for all layers of society.

In addition, the enhancement of health digitalization is an important parameter in the development of a smart green city. The improvement of health digitalization is not only beneficial in enhancing performance in the health sector but also has a positive impact on economic and political stability. Several innovative products have been developed by the East Sumba Government, but it seems that data integration is still needed to achieve good data centralization. In relation to the above, the role of the government in enhancing the development of a smart green city based on health

digitalization has become one of the main indicators in improving the performance of health services in East Sumba.

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