OPEN ACCESS

International
Journal
Of Modern Engineering Research (IJMER)

Digital Transformation and Sustainable Urban Planning in Coastal Peripheral Regions: A Case of Wasior District, West Papua

Diyanto Sarira*[1], Agustina Nurul Hidayati[2], Agung Witjaksono[3]
[1]*Master's Program in Civil Engineering, Postgraduate Programs, Institut Teknologi Nasional Malang, Malang City, Indonesia*
[2,3]*Departement of Urban and Regional Planning, Faculty of Civil Engineering and Planning, Institut Teknologi Nasional Malang, Malang City, Indonesia*
**Corresponding Author*

ABSTRACT:*West Papua Province is one of the regions in Eastern Indonesia currently facing significant development challenges, including limited infrastructure, complex geographical conditions, and a high level of regional isolation. Wasior District, as an administrative and economic center, exemplifies these structural constraints, which have been further intensified by environmental risks following the 2010 flash flood disaster. Nevertheless, recent expansions of communication networks in coastal villages such as Manggurai, Iriati, and Manopi have created new opportunities for digital transformation and sustainable regional development. This study employed a mixed-methods approach, combining quantitative statistical analysis to assess the Digital Readiness Index (DRI) and qualitative methods to explore the social, cultural, and community contexts influencing technology adoption. The results indicate a very high level of digital readiness, with an overall score of 84.85%. Communities generally perceive digital technology as useful and easy to use for improving access to communication, education, healthcare, public services, and economic activities. However, technology adoption remains constrained by limited digital infrastructure, internet connectivity, and digital literacy, particularly in remote areas. Despite these challenges, the strong intention of local communities to adopt digital technologies highlights substantial potential for implementing the Smart Coastal Living concept in Wasior District.*
KEY WARDS: *Digital transformation, smart coastal living, digital readiness, technology acceptance model (TAM)*

Date of Submission: 25-07-2026 Date of acceptance: 07-08-2026

I. INTRODUCTION

Peripheral coastal regions in developing countries currently face a dual development challenge: acute geographic isolation and a widening digital divide[1]. In Eastern Indonesia, particularly in West Papua Province, these vulnerabilities are exacerbated by complex topography, limited physical infrastructure, and a high degree of regional isolation[2] While metropolitan areas are advancing rapidly through the integration of technological innovations into urban governance[3], remote regions are often left behind in this technological leap[4]. As a result, conventional top-down spatial planning paradigms often fail to respond to local socio-ecological dynamics[5], necessitating a new approach that is more adaptive, inclusive, and based on digital technology[6].

Wasior District, located in the coastal region of TelukWondama Regency, is a clear example of these structural barriers[7] As a center of economic and governmental activity, development in Wasior continues to be overshadowed by massive environmental risks, particularly in the wake of the flash flood disaster that occurred in 2010. On the other hand, data from the Central Statistics Agency (BPS) show that internet penetration in West Papua remains at a relatively low, early stage—around 30%[8]. This situation illustrates how geographical constraints directly limit the public's access to public services, educational infrastructure, and digital health facilities[9]. Despite these limitations, recent initiatives to expand communication networks have begun to open up opportunities for digitalization in various coastal villages in Wasior, such as Manggurai Village, Iriati Village, and Manopi Village. This increased internet access creates strategic momentum to redefine the spatial planning of remote areas[10]. The concept of a smart city is no longer viewed merely as the digitization of public services[11], but rather as an innovative tool for improving the quality of life for communities through

the application of technology in smart transportation, energy management, healthcare, education, and environmental safety systems[12], [13].

For this socio-technological transformation to proceed effectively, the integration of these concepts must be grounded in modern planning theory. According to Giffinger et al (2007), the dimensions of "smart living" and "smart people" place society at the center of development (people-centered development), where technology serves as an enabler to create tangible social well-being[14]. This perspective aligns with Batty's (2013) complex systems theory, which views cities as networks of interconnected dynamic subsystems[15]. Therefore, the community's readiness to adopt technology must be measured behaviorally using the Technology Acceptance Model (TAM) to ensure that the digital systems offered possess perceived ease of use and perceived usefulness that are recognized locally[16].However, there is a significant knowledge gap in the current regional planning literature. Most previous research on smart cities has been dominated by developed urban areas supported by mature infrastructure and human resources[17], [18]. There are still very few empirical studies that specifically examine how smart living components can be integrated into the characteristics of remote coastal areas with high disaster vulnerability[19], [20]. Furthermore, the approaches used in previous literature tend to be technology-based and top-down, and they fail to adequately examine the role of social capital and active community participation as key drivers of digital transformation[21], [22].

This study aims to bridge that gap by formulating a contextual model called "Smart Coastal Living" in Wasior District. Unlike conventional technocratic approaches, this study offers a systemic integration of quantitative digital readiness index measurements and a participatory social approach through Participatory Action Research (PAR). The research focuses not merely on the sophistication of technological devices, but on the readiness, adoption, and collaboration of local actors, so that spatial isolation can be transformed into opportunities for inclusive and sustainable innovation.

The primary objective of this study is to analyze the level of digital readiness, technology acceptance, and social networks among communities in order to formulate an adaptive Smart Coastal Living model in peripheral coastal areas. Specifically, this study aims to achieve four empirical objectives: first, to analyze the level of digital readiness (Digital Readiness Index) of communities across various sectors; second, to identify perceptions of ease, benefits, and behavioral barriers in technology adoption; third, to map the structure of social networks and key actors (change agents) in the dissemination of digital information; and fourth, to formulate strategic recommendations and an implementation model for Smart Coastal Living that supports sustainable urban planning.

II. MATERIAL AND METHODS

2.1 Methodological Approach

This study employs a mixed-methods approach that integrates qualitative and quantitative methods. This approach was chosen because it involves various philosophical assumptions and the simultaneous use of qualitative and quantitative methods, thereby yielding far greater research strength than separate approaches [23]. In this study, qualitative methods were used to gain an in-depth understanding of the social and cultural context, as well as the various needs of the community, while quantitative methods were used to measure the level of digital literacy, infrastructure readiness, and community acceptance of technology.

This study employs the Participatory Action Research (PAR) approach as its primary strategy, which involves the community as active participants in the process of identifying problems, formulating solutions, and implementing actions[24]. This approach was chosen because it is relevant to the conditions of the region, which requires direct community involvement in the digital transformation process within the study area.

2.2 Study Area

This study was conducted in Wasior District, TelukWondama Regency, West Papua Province, Indonesia, which serves as the center of economic and governmental activities and plays a vital role in driving regional development. Administratively, Wasior District consists of 9 villages and 1 urban village, covering an area of 210.70 km². Some of the villages that served as the main research sites include Manggurai Village, Iriati Village, and Manopi Village. The district's strategic position as a center of government and trade makes it a region that plays a vital role in the development of TelukWondama Regency.

However, this region is currently facing various constraints due to its coastal geography, a history of flash floods, and limited digital infrastructure—all of which pose major challenges to the creation of a sustainable city. Therefore, an innovative approach is needed that integrates digital transformation and the concept of smart living through sustainable urban planning in coastal outlying areas.

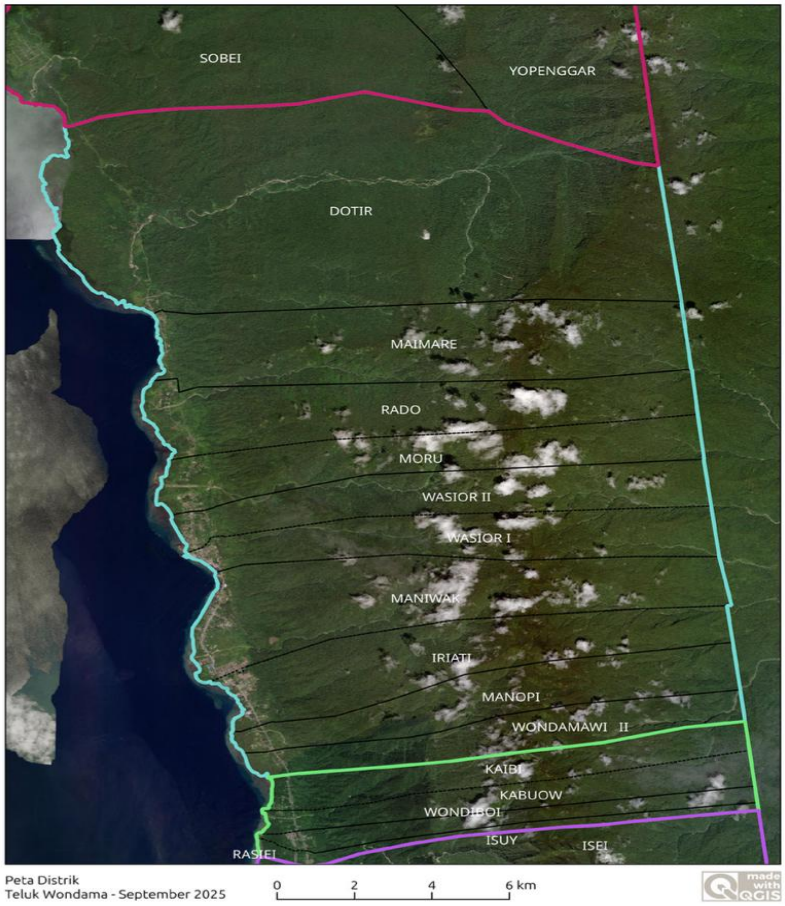

Figure 1: Map of Study Area

2.3 Sampling Design

In this study, sampling was conducted using the stratified random sampling technique, which involves randomly selecting a sample by dividing the study population into several subpopulations—known as strata—that can improve the accuracy of estimates of the characteristics of the entire population based on specific characteristics deemed relevant to the research variables [25], [26]. This technique was chosen because it is considered capable of providing more accurate results compared to conventional random sampling methods [25].

The population of Wasior District is heterogeneous, so it is necessary to classify it into relatively homogeneous groups so that each group has an equal opportunity to be represented in the sample. In this study, the population consists of all residents of Wasior District, stratified by age group—comprising adolescents, adults, and the elderly—gender, educational level, occupation, and residential area, which includes Manggurai Village, Iriati Village, and Manopi Village. Regarding age groups, the primary focus is on the productive age group between 16 and 64 years old, as they exhibit a higher rate of technology adoption. However, other age groups are still included to provide a comprehensive picture. The selection of stratification variables was based on the consideration that demographic, social, and spatial characteristics can influence digital literacy levels, technology acceptance, community participation, and perceptions of smart living implementation, in order to ensure adequate representation so that variations in community characteristics can be accommodated in the analysis process.

In this study, the sample size was set at 100 respondents, selected using the proportionate stratified random sampling technique, in which the number of respondents in each stratum is determined proportionally based on the proportion of the population in each group, thereby ensuring that the sample is representative of the population [27].

2.4 Data Collection Methods

The data used in this study were obtained from primary and secondary sources. The types and sources of each data set are as follows:

Table 1. Data Collection

Primary Data	Secondary Data
Questionnaire To measure: • Digital Literacy • Technology Acceptance • Digital Readiness	• Government Reports • Statistical Data • Scientific Journals • National and Regional Policy Documents
Interview Performed on: • Community Leaders • Local Government • Business Owners	
Focus Group Discussion (FGD) Done to: • Identifying community needs • Designing participatory solutions	
Field Observation Done to: • Assessing the actual state of digital infrastructure	

2.5 Analytical Framework

In conducting this study, data analysis was carried out in an integrated manner using a combination of quantitative and qualitative approaches to gain a comprehensive understanding of digital transformation and the development of the concept of smart living in Wasior District.

2.5.1 Quantitative Analysis

There are several stages of analysis that must be conducted quantitatively to produce a comprehensive and context-specific digital transformation model. These stages of analysis are as follows.

1. Analysis of the Technology Acceptance Model (TAM/UTAUT)

   This analysis is used to measure the level of public acceptance of digital technology in support of the concept of smart living [28]. The analysis is based on the public's perceptions of perceived ease of use, perceived usefulness, interest in using the technology, and the availability of conditions that facilitate the use of digital technology[29], [30].

2. Digital Readiness Index (DRI) Analysis

   This analysis is used to measure the level of the community's digital readiness in the face of digital transformation in Wasior District, with the measurement based on several key aspects, namely access to digital technology, the use of digital technology, the community's digital capabilities or literacy, and the community's readiness to embrace the development of digital services—which encompasses eight indicators, including smart transportation, energy management, water management, access to digital education, access to digital healthcare, technology-based waste management, technology-based environmental management, and environmental safety and comfort[31], [32]. In this study, the DRI measurement was conducted by distributing questionnaires to 100 respondents from several areas in Wasior District. The assessment was conducted using a 1–5 Likert scale as follows:

   - 1 = Strongly Disagree
   - 2 = Disagree
   - 3 = Netral
   - 4 = Agree
   - 5 = Strongly Agree

   Therefore, the index value is calculated using the following formula:

$$DRI\ Indeks\ = \frac{\sum(Answer\ Score)}{Score\ Maximum} \times 100\% \quad \text{.....(1)}$$

Description:

- ∑ Answer Score =Total score of all respondents' answers
- Maximum Score =Number of respondents × highest Likert score (5)
- Total Respondents = 100 People

DRI Index Rating Categories

Table 2. DRI Index

Index Percentase	Category
0% – 20%	Very low
21% – 40%	Low
41% – 60%	Moderate
61% – 80%	High
81% – 100%	Very High

3. Social Network Analysis (SNA)

This analysis is used to examine patterns of social relationships and community interactions in support of the digital transformation process in Wasior District, with the aim of identifying key actors or figures in the community, analyzing patterns of information dissemination, examining relationships among stakeholders, and identifying agents of change in the adoption of digital technology within the community[33], [34].

2.5.2 Qualitative Analysis

Qualitative analysis was conducted on data from interviews, field observations, Focus Group Discussions (FGDs), and Participatory Action Research (PAR). The data were then analyzed using coding techniques with NVivo/Atlas.ti software; thematic categorization; data triangulation; and narrative interpretation[35]. This analysis aimed to understand the social conditions of the community, barriers to digital transformation, community needs, and forms of community participation in the development of the smart living concept in Wasior District.

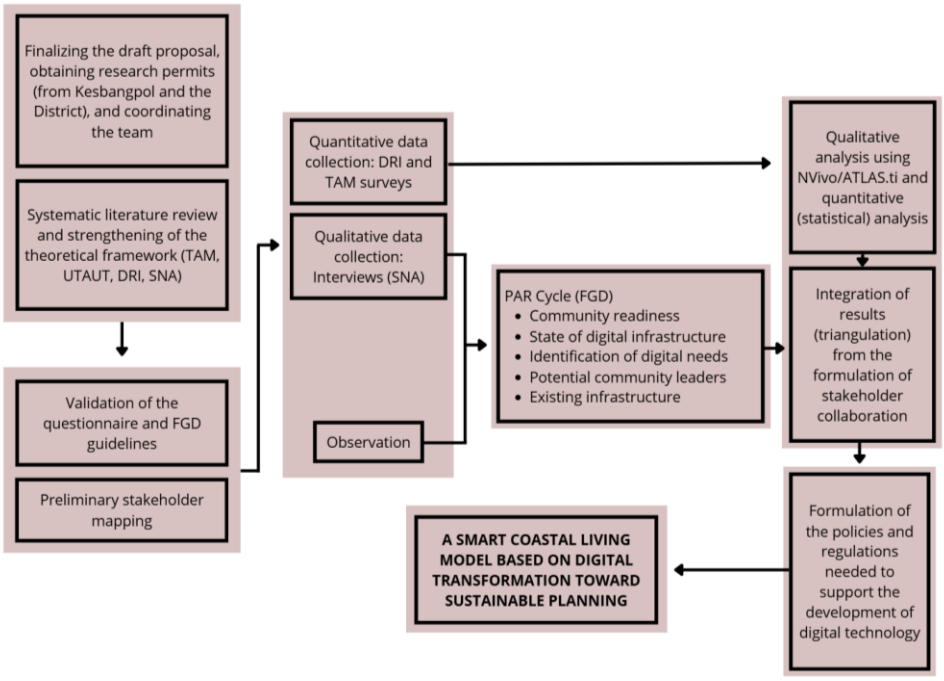

Figure 2: Flowchart of the Research

III. RESULTS AND DISCUSSIONS

3.1 Digital Readiness Index (DRI) Results

A. Smart Transportation

Smart transportation indicators are used to gauge public perception of the need for a more effective, safe, accessible, and digitally-based transportation system in Wasior District. Based on the Digital Readiness Index (DRI) calculations, the Smart Transportation indicator scored 84.4% and falls into the "very high" category. These results indicate that the residents of Wasior District have a high level of readiness and need for the development of a transportation system supported by digital technology. The results of the Digital Readiness Index calculation for the smart transportation indicator are as follows:

$$\frac{422}{500} \times 100 = 84{,}4\% \textbf{ Very High Category}$$

This high score indicates that the public views easy access to transportation information, improved interregional connectivity, and the use of digital technology as key factors in supporting daily mobility. This situation also reflects a high level of acceptance of technology-based transportation innovations that can improve travel efficiency, access to public services, and economic activity among the public.

B. Energy Management

The energy management indicator is used to gauge public perception of the need for more efficient, cost-effective, stable, and digitally-based energy management in Wasior District. Based on the Digital Readiness Index (DRI) calculation results, the energy management indicator scored 82.8% and falls into the "very high" category. These results indicate that the community in Wasior District has a high level of readiness to utilize technology in energy management to support daily activities and sustainable regional development. The results of the Digital Readiness Index calculation for the energy management indicator are as follows:

$$\frac{414}{500} \times 100 = 82{,}8\% \textbf{ Very High Category}$$

This figure indicates that the public recognizes the importance of a stable, efficient, and equitably accessible energy supply to support various social, economic, educational, health, and public service activities. In the era of digital transformation, energy availability has become a critical factor, as all technology-based services rely heavily on an adequate electricity supply and energy infrastructure.

C. Water Management

Water management indicators are used to gauge community perceptions regarding the need for more effective, clean, and sustainable water resource management based on digital technology in Wasior District. Based on the Digital Readiness Index (DRI) calculation results, the water management indicator scored 83% and falls into the "very high" category. These results indicate that the community in Wasior District has a high level of readiness and awareness regarding effective, sustainable water resource management supported by the use of digital technology. The results of the Digital Readiness Index calculation for the water management indicator are as follows:

$$\frac{415}{500} \times 100 = 83\% \textbf{ Very High Category}$$

This high score indicates that the public recognizes the importance of clean water as a basic necessity for supporting quality of life, public health, and social and economic activities. In addition, the public also has high expectations for improvements to the water management system that can ensure equitable and sustainable access to clean water.

D. Access to Digital Education

The digital education access indicator is used to gauge public perceptions regarding the need for more accessible educational services through the use of digital technology in Wasior District. Based on the Digital Readiness Index (DRI) calculations, the digital education indicator scored 92% and falls into the "very high" category. These results indicate that the community in Wasior District has a very high level of readiness, need, and support for the use of digital technology in the education sector. The results of the Digital Readiness Index calculation for the digital education access indicator are as follows:

$$\frac{460}{500} \times 100 = 92\% \textbf{ Very High Category}$$

This very high score indicates that the public recognizes the importance of digital technology as a means to improve access to education, enhance the quality of learning, and expand sources of information and knowledge. The high level of acceptance of digital education also reflects the public's expectation that

educational services will keep pace with technological advancements and address the challenges of the digital transformation era.

E. Digital Health Access

The digital health access indicator is used to gauge public perceptions regarding the need for faster, more convenient, and digitally-based health services in Wasior District. Based on the Digital Readiness Index (DRI) calculations, the digital health indicator scored 100% and falls into the "very high" category. These results indicate that the community in Wasior District has a very high level of readiness, need, and support for the use of digital technology in health services. The results of the Digital Readiness Index calculation for the digital health access indicator are as follows:

$$\frac{500}{500} \times 100 = 100\% \textbf{ Very High Category}$$

A score of 100% indicates that all respondents gave a positive assessment of the importance of developing digital-based health services. This suggests that the public recognizes that digital technology can help improve access to health services, expedite the delivery of medical information, and support improvements in the quality of health services more effectively and efficiently.

F. Waste Management

Technology-based waste management indicators were used to assess community perceptions regarding the need for a more effective, organized, and environmentally friendly waste management system through the use of digital technology in Wasior District. Based on the Digital Readiness Index (DRI) calculations, the technology-based waste management indicator scored 79% and fell into the "high" category. These results indicate that the community in Wasior District has a good level of readiness for the application of technology in waste management, although there are still several aspects that need improvement to support more effective and sustainable environmental management. The results of the Digital Readiness Index calculation for the waste management indicator are as follows:

$$\frac{395}{500} \times 100 = 79\% \textbf{ High Category}$$

This score indicates that the public understands the importance of waste management as part of efforts to maintain environmental cleanliness and quality of life. However, compared to the digital education and digital health indicators—which received a "very high" rating—the waste management score, which remains in the "high" category, suggests that the use of technology in this sector has not yet fully developed and requires further attention.

G. Technology-Based Environment

Technology-based environmental indicators were used to assess community perceptions regarding the need to utilize technology in maintaining environmental quality and supporting sustainable development in Wasior District. Based on the Digital Readiness Index (DRI) calculations, the technology-based environmental indicators scored 77.6% and fell into the "high" category. These results indicate that the community in Wasior District has a good level of readiness for the use of technology in environmental management and conservation, although certain aspects still need to be strengthened to achieve more optimal conditions. The results of the Digital Readiness Index calculations for the waste management indicator are as follows:

$$\frac{388}{500} \times 100 = 77{,}6\% \textbf{ High Category}$$

This figure indicates that the public has a fairly high level of awareness regarding the importance of preserving environmental quality through the use of digital technology. This awareness is evident in the public's support for the use of technology in monitoring environmental conditions, managing natural resources, and preventing environmental pollution that could adversely affect the public's quality of life.

H. Digital-Based Environmental Security

Digital-based community safety indicators are used to gauge public perceptions regarding the need for a more effective and responsive community safety system through the use of digital technology in Wasior District. Based on the Digital Readiness Index (DRI) calculation results, the digital-based community safety indicators scored 82% and fell into the "very high" category. These results indicate that the community in Wasior District has a very high level of readiness and support for the use of digital technology to improve environmental safety and public order. The results of the Digital Readiness Index calculation for the digital-based environmental safety indicator are as follows:

$$\frac{410}{500} \times 100 = 82\% \textbf{ Very High Category}$$

These high scores indicate that the public views security as a key factor in supporting quality of life and sustainable regional development. In addition, the public has high expectations for the use of digital technology to help improve environmental monitoring, the dissemination of security information, and responses to potential security threats and disasters.

I. Overall Summary of Indicators

Based on the results of a questionnaire survey of 100 respondents in Wasior District, it was found that the community's level of readiness and need for the implementation of Smart Coastal Living based on digital transformation falls into the "very high" category. The calculations for all of these indicators are as follows:

$$\frac{678{,}8}{8} \times 100 = 84{,}85\% \textbf{ Very High Category}$$

The high index score is influenced by the public's growing need for more effective access to public services, the use of information technology in daily life, and public expectations for more modern, efficient, and sustainable regional development.

4.1 Technology Acceptance Model (TAM) Results

A. Perceived Ease of Use

Based on the results of the questionnaire and interviews, the majority of respondents stated that the use of digital technology is becoming an essential part of people's lives. The public believes that the use of smartphones, social media, communication apps, and internet access has helped facilitate communication, obtain information, and support educational activities and public services. The research findings indicate that residents in the central area of Wasior District tend to adapt more easily to the use of digital technology compared to those in areas with limited internet connectivity; factors such as age, educational level, and prior experience with technology also influence how easily people can use digital services.

Nevertheless, some respondents still face difficulties in using certain technologies due to limited digital knowledge and a lack of training in technology use. This situation clearly indicates that improving digital literacy remains a critical need in supporting the implementation of smart living based on digital transformation in Wasior District.

B. Perceived Usefulness

Based on the results of questionnaires, interviews, and Focus Group Discussions (FGDs), it was found that the majority of respondents stated that the use of digital technology has a positive impact on the ease of accessing information, communication, education, health services, and community economic activities. Thus, digital technology is considered capable of helping the community access information more quickly and efficiently compared to conventional methods. However, the research findings also indicate that the benefits of digital technology have not yet been felt equally by the entire community. Some regions still face limitations in internet connectivity and other supporting infrastructure, resulting in suboptimal technology utilization. Additionally, there remains a segment of the population that lacks sufficient digital literacy to make the most of these technologies.

C. Facilitating Conditions

The research findings indicate that the conditions supporting technology adoption in Wasior District are still in the early stages of development. Results from questionnaires, interviews, and focus group discussions (FGDs) show that the community is beginning to gain access to digital devices such as smartphones and the internet, particularly in the central area of Wasior District. The availability of telecommunications networks and the use of digital media in daily life are contributing to the digital transformation process within the community. However, field observations indicate that digital infrastructure in several villages still faces various limitations. The main issues identified include unstable internet connectivity, limited signal coverage in some coastal areas, and a lack of information technology support facilities. These conditions represent one of the barriers to equitable digital transformation in Wasior District.

D. Behavioral Intention

Based on the results of a questionnaire administered to 100 respondents, the majority of the community expressed a strong interest in utilizing digital technology to support various activities, such as communication, education, health, public services, and economic activities. Respondents noted that the use of digital technology can provide convenience, efficiency, and faster access to information compared to conventional methods. The

results of interviews and Focus Group Discussions (FGDs) indicate that the community has high expectations for the development of digital services that can help improve the quality of life and public services in Wasior District. The community also expressed interest in using digital applications that support daily needs, including government information services, digital education, health services, and community communication. Furthermore, the public's high interest in using technology indicates that digital transformation holds significant potential for implementation in support of the "Smart Coastal Living" concept. The public not only accepts the presence of digital technology but also demonstrates a readiness to utilize it provided it is supported by adequate infrastructure and services.

4.2 Network Topology of Digital Diffusion (SNA Mapping) Results

Social Network Analysis (SNA) uses a relational approach to map how information technology and digital education are disseminated in Wasior District. Based on calculations of centrality parameters (degree, betweenness, and closeness centrality), the network's topological structure in the study area exhibits semi-centralized characteristics, with the following details:

- Government Agencies and Villages as Institutional Hubs: District governments and village officials (such as those in the villages of Manggurai, Iriati, and Manopi) have the highest degree centrality scores. This reinforces their position as key nodes (centers for data and policy) that control the dissemination of formal e-government programs and inter-agency coordination (such as between the Communications and Information Technology Office and the Regional Disaster Management Agency).
- Youth Communities as Bridging Actors: Amid the limitations of formal bureaucracy, local youth groups and associations have emerged as bridging actors (bridging nodes) with significant betweenness centrality. They serve to bypass rigid bureaucratic channels (institutional bottlenecks) to accelerate the horizontal transfer of digital literacy directly to the general public and small and medium-sized enterprises (SMEs).

4.3 Narrative Syntheses from PAR & Community Co-Design Results

Through a cycle of Participatory Action Research (PAR) and Focus Group Discussions (FGD) involving various segments of the community, a narrative synthesis was successfully formulated regarding local needs and structural dependencies in the implementation of technology:

- Energy Supply Stability (Electrical Grid Stability): The Wasior coastal community firmly asserts that digital transformation will not function optimally without guaranteed electrical power stability. Frequent power outages have been identified as the primary threat to the sustainability of smart devices and public service servers.
- Offline-First Network Architecture: Given the coastal geography, which causes cellular signal quality to be highly volatile and susceptible to weather disruptions (cellular volatility), the community and researchers have agreed that the proposed digital platform must be based on an offline-first architecture. This means that public service applications (such as ferry transportation information or educational resources) must remain accessible and store data locally without relying entirely on a real-time internet connection, and then automatically synchronize when the signal becomes stable again.

IV. CONCLUSIONS AND DISCUSSION

4.1 Conclusions and Discussion

A. The Conceptual Blueprint of "Smart Coastal Living"

The Smart Coastal Living model developed in this study is a deconstruction of the conventional smart city concept, redefined to be adaptable to the characteristics of remote coastal areas. Based on the results of a co-design process with the community of Wasior District, this conceptual blueprint is built upon six interconnected structural nodes:

- Robust Infrastructure: A solid foundation that focuses not only on expanding telecommunications towers, but also on the reliability of supporting infrastructure—such as a stable power supply—to ensure the sustainability of the coastal digital ecosystem.
- Human Capital Literacy: Inclusively enhancing the public's digital capacity and skills, transforming them from mere passive social media users into productive agents in utilizing local digital platforms.

- Translucent E-Governance: The digitization of public administration and district/village services that are transparent, responsive, and easily accessible to cut through rigid bureaucracy (institutional bottlenecks).
- Polycentric Stakeholder Alliances: A collaborative governance model that brings together local governments, academics, operators, the private sector, and community leaders in an equal partnership network to support program sustainability.
- Environmental Risk Warning Modules: Integration of sensor-based environmental information systems and coastal disaster mitigation measures—such as an Early Warning System (EWS) for flash floods—that are directly linked to residents' mobile devices. Marine/SME Value Networks: Strengthening the local circular economy through the use of digital platforms for promotion, monitoring of fishery and agricultural commodity prices, and expanding market access for Wasior's flagship products.

B. Resolving the Spatial Paradox of Peripheral Regions

Empirical findings in Wasior District reveal an acute spatial paradox: a stark contrast between the community's high interest and social willingness to adopt a digital ecosystem and extreme geographical constraints in the form of areas without signal coverage (blank spots). Based on field observations and DRI analysis, areas outside the district center—such as the villages of Rado, Dotir, and Maimari—remain digitally isolated due to severely limited or nonexistent network coverage. This phenomenon demonstrates that the conventional, linear approach to providing digital infrastructure often fails to address the challenges faced by remote island and coastal regions.

To overcome these obstacles, modern spatial planning in suburban areas must shift from a centralized macro-network model toward a "Micro-Grid Cellular Clustering" strategy. Through this approach, blank spots are divided into small-scale, self-sufficient clusters supported by local signal repeaters and village-based public Wi-Fi. These clusters are then integrated with an "offline-first" application architecture derived from the PAR cycle, ensuring that the exchange of public service data and disaster information can continue to operate communally without absolute reliance on real-time global internet connections. Thus, spatial planning is no longer merely resigned to geographical constraints but actively fosters self-sufficient local digital resilience.

C. Interfacing Local Action with Global Sustainable Mandates

The concept of sustainable development serves as the primary foundation for guiding regional transformation, particularly in the development of Wasior District as it addresses various challenges related to infrastructure, digital connectivity, and institutional capacity building—which integrates information and communication technology into government governance, public services, the economy, mobility, the environment, and the quality of life for the community. This approach aligns with the Sustainable Development Goals (SDGs), particularly Goal 9 (industry, innovation, and infrastructure), Goal 11 (sustainable cities and communities), and Goal 16 (peace, justice, and strong institutions), which emphasize the importance of innovation, resilient infrastructure, inclusive cities, and effective institutions in supporting sustainable development.

Research findings on the community's digital readiness and literacy indicate that, in general, the residents of Wasior District have a fairly high level of digital readiness to support the adoption of digital technology and the development of the "smart living" concept. The DRI analysis results indicate that the digital readiness level of the Wasior District community falls into the "very high" category, with a percentage of 84.85%, indicating that the community is well-prepared to support digital transformation and the development of Smart Coastal Living. The community is beginning to understand the importance of digital technology in supporting access to education, health services, public services, communication, and community economic activities. However, there are still several obstacles, such as limited digital literacy among some members of the community and the uneven distribution of digital technology proficiency across the Wasior District.

In terms of digital infrastructure, Wasior District has seen significant progress compared to previous years, particularly regarding access to communication networks and the internet. However, research findings indicate that there are still some areas experiencing limited internet coverage and "dead zones," especially in regions far from the district center. In addition to internet connectivity limitations, Wasior District also faces

various other challenges, including the geographical conditions of its coastal areas, limited technological infrastructure, and vulnerability to natural disasters that can affect the stability of these digital services.

In terms of policy and community participation, the research findings indicate that collaboration among local governments, the community, community leaders, educators, youth groups, and other stakeholders plays a crucial role in supporting digital transformation in Wasior District. Through Participatory Action Research (PAR), interviews, and Focus Group Discussions (FGDs), the community has demonstrated a fairly high level of participation in supporting the development of digital services and technology-based development. Furthermore, the results of Social Network Analysis (SNA) also indicate that community leaders and youth groups exert significant influence in the process of disseminating information and strengthening digital transformation within the community.

Thus, the Smart Coastal Living model in this study aligns with the concepts of sustainable development goals 9, 11, and 16, which emphasize strengthening digital infrastructure, improving community digital literacy, developing digital-based public services, establishing environmental and disaster information systems, strengthening the community's digital economy, and fostering active community participation in the regional development process.

D. Methodological Contribution

The research findings indicate that the success of digital transformation in Wasior District is not only determined by the availability of technology but is also influenced by the strength of the community's social networks, which play a role in accelerating the dissemination of information to improve digital literacy and build trust in technological innovations. The results of this study also indicate that the community's digital readiness, high acceptance of technology, support from social networks, and active community participation are key assets in the development of Smart Coastal Living based on digital transformation. Therefore, the resulting model can serve as an alternative approach to support adaptive, participatory, and sustainable coastal zone planning in Wasior District as well as other coastal areas in Indonesia.

REFERENCES

[1] M. A. Xueguang and J. Ce, "Global submarine cable network and digital divide," vol. 35, no. 6, pp. 1204–1232, 2025.

[2] D. Sett *et al.*, "HAZARDS , EXPOSURE AND VULNERABILITY IN INDONESIA : A risk assessment across regions and provinces to inform the development of an Adaptive Social Protection Road Map REPORT IN INDONESIA :," Indonesia, 2022.

[3] X. Ma, J. Li, Z. Guo, and Z. Wan, "Role of big data and technological advancements in monitoring and development of smart cities," *Heliyon*, vol. 10, no. 15, p. e34821, 2024, doi: 10.1016/j.heliyon.2024.e34821.

[4] S. Sindakis and G. Showkat, "The digital revolution in India : bridging the gap in rural technology adoption," *J. Innov. Entrep.*, 2024, doi: 10.1186/s13731-024-00380-w.

[5] H. M. . Herath, "Social-Ecological Resilience in Spatial Planning : A Literature Review," *Bhúmi, Plan. Res. J.*, vol. 12, no. 01, 2025.

[6] K. Kalip, Y. D. Bakti, E. Ebariani, and C. Dewi, "Education in the Digital Age : Creating Inclusive and Adaptive Learning Environments," International Conference on Christian and Inter-Religious Studies (ICC-IRS 2024), 2025. doi: 10.2991/978-2-38476-424-2.

[7] N. E. Nugroho, I. M. Pratiwi, and A. D. Siregar, "POTENTIAL OF LIMESTONE AND QUARTZ SAND IN ROSWAR AND RUMBERPON DISTRICTS , TELUK WONDAMA REGENCY , WEST PAPUA PROVINCE," vol. 9, no. 3, pp. 47–52, 2024.

[8] A. H. Natanegara, L. Budiman, and M. Nidhal, "Understanding the regulatory environment for ICT infrastructure in Papua New Guinea Understanding the Regulatory Environment for ICT Infrastructure in Papua New Guinea," Jakarta, Indonesia, 2023.

[9] T. H. Akingbemisilu, "A Critical Evaluation of Government Role in Spatial Data Infrastructures for Healthcare Decision-Making," *J. Public Policy Adm.*, vol. 8, no. 1, pp. 14–23, 2024, doi: https://doi.org/10.11648/j.jppa.20240801.13.

[10] B. Li, "Digital infrastructure and regional economic disparities : Evidence from the broadband China strategy Digital infrastructure and regional economic disparities :," *Econ. Innov. New Technol.*, vol. 8599, pp. 1–20, 2025, doi: 10.1080/10438599.2025.2581600.

[11] E. A. Rijshouwer and E. M. Leclercq, "Public views of the smart city : Towards the construction of a social problem," 2022, doi: 10.1177/20539517211072190.

[12] H. A. Sulaimon and A. A. Fadele, "Smart communities : enhancing local processes through artificial intelligence and quality of life," in *Proceedings of the Nigerian Society of Physical Sciences 2*, 2025. doi: 10.61298/pnspsc.2025.2.187.

[13] Z. Mohammadzadeh, H. R. Saeidnia, A. Lotfata, M. Hassanzadeh, and N. Ghiasi, "Smart city healthcare delivery innovations : a systematic review of essential technologies and indicators for developing nations," vol. 8, pp. 1–14, 2023, doi: https://doi.org/10.1186/s12913-023-10200-8.

[14] F. Ahmadi, "Smart Cities and Climate Risk Mitigation and Adaptation : Smart Technologies and Strategies for Resilient Urban Smart Cities and Climate Risk Mitigation and Adaptation : Smart Technologies and Strategies for Resilient Urban Development .," NOVA University Lisbon, 2025.

[15] J. Parysek and L. Mierzejewska, "City as a system : A systems approach to urban planning and development," vol. 68, no. 68, pp. 7–28, 2025, doi: http://doi.org/10.12775/bgss-2025-0011.

[16] A. Ibrahim, E. Shiring, E. The, A. Ibrahim, and E. Shiring, "The Relationship between Educators ' Attitudes , Perceived Usefulness , and Perceived Ease of Use of Instructional and Web-Based Technologies : Implications from Technology Acceptance Model (TAM) To cite this article : The Relationship between Educators," *Int. J. Technol. Educ.*, vol. 5, no. 4, pp. 535–551, 2022, doi: https://doi.org/10.46328/ijte.285.

[17] M. M. Haque, "QUANTITATIVE ASSESSMENT OF SMART CITY IOT INTEGRATION FOR REDUCING URBAN INFRASTRUCTURE VULNERABILITIES," *Rev. Appl. Sci. Technol.*, vol. 03, no. 04, pp. 48–93, 2024, doi: 10.63125/f2cj4507.
[18] Z. Chen, I. Cheng, and C. Chan, "Smart cities and quality of life : a quantitative analysis of citizens ' support for smart city development," *Inf. Technol. People*, vol. 36, no. 1, pp. 263–285, 2023, doi: 10.1108/ITP-07-2021-0577.
[19] P. Shen, S. Wei, H. Shi, L. Gao, and W. Zhou, "Coastal Flood Risk and Smart Resilience Evaluation under a Changing Climate," *Ocean. Res.*, 2023, doi: 10.34133/olar.0029.
[20] K. Seong, "Is a Smart City Framework the Key to Disaster Resilience? A Systematic Review," *J. Plan. Lit.*, vol. 39, no. 1, pp. 62–78, 2024, doi: 10.1177/08854122231199462.
[21] D. Van Tran, P. Van Nguyen, S. Thi, N. Nguyen, and T. N. Huynh, "Determining the antecedents of digital transformation and performance: the roles of social capital, open social innovation, absorptive capacity and government support," *Eur. J. Innov. Manag.*, vol. 28, no. 8, pp. 4202–4224, 2024, doi: 10.1108/EJIM-08-2024-0917.
[22] N. Hoang, A. Dat, T. N. Ghi, and N. Q. Huan, "Social Capital, Human Capital, Access to Resources, Digital Transformation, Business Model Innovation and Firm Performance," *J. Organ. Behav. Res.*, vol. 10, no. 1, pp. 128–140, 2025.
[23] J. W. Creswell, *RESEARCH DESIGN Qualitative, Quantitative, and Mixed Methods Approaches*, Third. SAGE Publications, 2009. [Online]. Available: https://www.ucg.ac.me/skladiste/blog_609332/objava_105202/fajlovi/Creswell.pdf
[24] S. Kemmis, R. McTaggart, and R. Nixon, *The Action Research Planner Doing Critical Participatory Action Research*. Springer, 2014. [Online]. Available: https://educons.edu.rs/wp-content/uploads/2020/05/2014-The-Action-Research-Planner.pdf
[25] M. R. Alzahrani and M. Almohaimeed, "Original article A novel approach for estimation Population Mean with Dual Use of in Stratified Random Sampling," *Alexandria Eng. J.*, vol. 119, no. December 2024, pp. 64–72, 2025, doi: 10.1016/j.aej.2025.01.057.
[26] W. G. Cochran, *Sampling Techniques*, Third Edit. Canada, 1977. [Online]. Available: https://share.google/ZllRKcCxA4i0YADbB
[27] H. R. Attamimi *et al.*, *Metode Penelitian*. Medan: PT. Literasi Nusantara Abadi Grup, 2023.
[28] F. Davis, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Q.*, vol. 13, pp. 319-, 1989, doi: 10.2307/249008.
[29] M. Liesa, O. Cecilia, L. Cosculluela, and V. Sierra, "Links between ease of use, perceived usefulness and attitudes towards technology in older people in university: A structural equation modelling approach," *Educ. Inf. Technol.*, pp. 2419–2436, 2023, doi: 10.1007/s10639-022-11292-1.
[30] M. Hafiz, H. Zubir, M. Safuan, and A. Latip, "Factors affecting citizens' intention to use e-government services: assessing the mediating effect of perceived usefulness and ease of use," *Transform. Gov. People, Process Policy*, vol. 18, no. 3, pp. 384–399, 2023, doi: 10.1108/TG-04-2023-0040.
[31] A. Pamuji, A. Susanty, and B. Warsito, "Investigating the Profile of Digital Readiness and Sustainability Development: An Explainable Clustering," in *The 3rd International Conference on Data Science and Official Statistics (ICDSOS)*, 2025, pp. 141–154.
[32] W. Anggraini and B. Pranggono, "intelligent dashboard decision support system Assessing Digital Readiness of Small Medium Enterprises : Intelligent Dashboard Decision Support System," *Int. J. Adv. Comput. Sci. Appl.*, vol. 13, no. 4, pp. 98–108, 2022.
[33] T. P. Lestari, "Jurnal Informatika Ekonomi Bisnis Analisis Text Mining pada Sosial Media Twitter Menggunakan Metode Support Vector Machine (SVM) dan Social Network Analysis (SNA)," *J. Inform. Ekon. Bisnis*, vol. 4, no. 3, pp. 65–71, 2022, doi: 10.37034/infeb.v4i3.146.
[34] M. K. Anam and M. I. Mahendra, "Framework for Analyzing Netizen Opinions on BPJS Using Sentiment Analysis and Social Network Analysis (SNA)," *INTENSIF J. Ilm. Penelit. dan Penerapan Teknol. Sist. Inf.*, vol. 6, no. 1, pp. 11–28, 2022.
[35] M. J. Beg, "Research : Standards for Ethical Inquiry ," *Indian J. Psychol. Med.*, vol. XX, no. X, pp. 1–6, 2025, doi: 10.1177/02537176251363817.