Smart Village Initiative in Indonesia: Governance's Perspective Using PESTLE Analysis

Inisiatif Desa Pintar di Indonesia: Perspektif Pemerintah menggunakan Analisis PESTLE

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Abstract: Globally, including in Indonesia, people have adopted the Smart Village Initiative. Although beneficial, the integration of information and communication technology (ICT) creates complexity in rural areas. The implementation of Smart Village varies due to different geographic, demographic, economic, and social backgrounds. Land-based implementations overcome challenges due to the dynamic nature of spatial data and attributes associated with land parcels, requiring an understanding of surveying as well as mapping for data updates and maintenance. This research aims to understand how these variations influence the implementation of smart villages and identify factors that impact the initiative. Using a comparative study approach, we analyzed the implementation of the Smart Village initiative in two different areas and assessed the results using the PESTLE analysis tool. The findings show that economic and social factors play an important role in shaping the design characteristics of the Smart Village, thereby creating significant differences between the two villages. These factors shape the inclusion of specific modules in the application. However, both face challenges related to community involvement, ICT culture, and environmental factors, which have an impact on optimizing utilization to achieve wider coverage and awareness in ICT adaptation.
Keywords: Smart Village, Parcel-Based Information System, PESTLE

Abstrak: Inisiatif Desa Cerdas diadopsi secara global, termasuk di Indonesia. Meskipun bermanfaat, integrasi Teknologi Informasi dan Komunikasi (TIK) menimbulkan kompleksitas di pedesaan. Penerapan *Smart Village* bervariasi karena latar belakang geografis, demografi, ekonomi, dan sosial yang berbeda. Implementasi berbasis tanah menghadapi tantangan karena sifat dinamis dari data spasial dan atribut yang terkait dengan bidang tanah, sehingga membutuhkan pemahaman survei serta pemetaan untuk pembaruan dan pemeliharaan data. Penelitian ini berupaya untuk memahami bagaimana variasi-variasi tersebut mempengaruhi pelaksanaan inisiatif Desa Cerdas dan mengidentifikasi faktor-faktor yang memberikan dampak terhadap inisiatif tersebut. Dengan menggunakan pendekatan studi komparatif, kami menganalisis implementasi inisiatif Desa Cerdas di dua bidang berbeda dan menilai hasilnya dengan menggunakan alat analisis PESTLE. Temuan menunjukkan bahwa faktor ekonomi dan sosial memainkan peran penting dalam membentuk karakteristik desain Desa Cerdas, sehingga menciptakan pembeda yang signifikan antara kedua desa tersebut. Faktor-faktor ini terutama mempengaruhi modul spesifik mana yang akan disertakan dalam aplikasi. Namun keduanya menghadapi tantangan terkait keterlibatan masyarakat, budaya TIK, dan faktor lingkungan, yang berdampak pada optimalisasi pemanfaatan untuk mencapai cakupan dan kesadaran yang lebih luas dalam adaptasi TIK.
Kata Kunci: *Smart Village*, Sistem Informasi Berbasis Parcel, PESTLE

Introduction

Information and communication technology (ICT) has been widely used in many areas of life, including the public sector. E-government has been quickly evolving over the last few decades, and in response to citizen and corporate needs, its implementation has changed public sector behavior (Schelin, 2007). The core premise behind e-government is that government agencies use electronic communications to connect with people, businesses, and other government bodies, with the primary goal of improving efficiency, transparency, and accessibility for citizens (Schelin, 2007). This idea is then expanded into e-governance, which extends beyond the use of ITC for government services to include the full governance process, including policymaking, decision-making, monitoring and evaluation, and increasing public participation and engagement in governance (Finger & Pécoud, 2003). The importance of e-governance may also be viewed as a form of practice in the execution of Good Governance (Okot-Uma & London, 2000; Basu, 2004), Smart Governance (Bifulco et al., 2016; Scholl & AlAwadhi, 2016), and the accomplishment of Sustainable Development (Estevez et al., 2013; Estevez & Janowski, 2013).

Within the framework of the Unitary State of the Republic of Indonesia, villages have independent competence to govern their territory. The passage of Law No. 6/2014 about Villages and Law No. 23/2014 concerning Regional Governments reinforces Indonesia's decentralization of government at the village level. This legislative development marks the turning point event. The implementation of e-governance has extended to village level, which constitutes the lowest tier within the national government structure. With the growing need for good governance practice at the village level, local governments must now implement Information and Communication Technology (ICT). The integration of ICT frameworks could further enhance the performance of village governments, thereby laying the groundwork for the advancement of smart governance initiatives (Adi & Heripracoyo, 2018; Adi & Suhartono, 2017; Afnarius et al., 2020; Marlintha et al., 2017; Salim, 2013).

The trend of smart village in Indonesia began in the early 2010s, but has only recently received major attention. Several smart village initiatives emerged in Indonesia between 2013 and 2014, with the original focus on improving village-level access to information technology. In 2017, the Indonesian government formally adopted the concept of smart village through a national initiative led by President Jokowi, who established the Digital Village initiative. The development of smart villages was first attempted to facilitate the implementation of previously announced Smart City initiatives (Rachmawati, 2018). Since then, smart village projects have gained momentum. Several government projects, programs, and private sector initiatives have been developed to encourage the development of Smart Villages. However, despite its progress, some obstacles remain that must be solved to improve its application. Adopting from the concept of Smart City by (Giffinger et al., 2007), there are six dimensions of smartness, which include smart living, smart environment, smart mobility, smart governance, smart people, and smart economy. Meanwhile, the Ministry of Communication and Information Technology formulates the dimensions of Smart City with elements

encompassing smart governance, smart society, smart economy, smart branding, smart living, and smart environment. In the context of land, Smart Village integrated with a parcel-based information system can also serve as a supporter of smart land governance. Parcel-based information, presented on a large scale, has the capability of providing field-based information presentation that can be utilized for various purposes. Essentially, the implementation of Smart City (including Smart Village) is not solely about the application of information technology but rather about Smart Governance aimed at enhancing quality of life and achieving sustainable development goals. However, ultimately, its implementation is more easily measurable in terms of the extent to which technology can be utilized in providing services to the community (Rachmawati, 2018). Nevertheless, considering the diverse conditions of villages, including their geographical characteristics, demographics, and socio-economic profiles, the implementation of smart villages can vary significantly. This diversity encompasses each village's capacity to build, implement, and utilize Smart Village initiatives, which may include financial, organizational, human resource, and other aspects. The design of Smart Village should be tailored, adjusting with the need of the village. While technology adaptation can be beneficial, it can also pose challenges. Moreover, as the smallest administrative unit, the implementation of smart villages can be more challenging compared to Smart City.

Given these circumstances, this study looks further into the use of parcel-based smart village apps to promote good governance practices in rural regions. By comparing examples of smart village implementation in regions with different geographical characteristics, this study aims to analyze how these characteristics influence ICT implementation (in the form of smart village) and identify the factors that possess significant effects on the implementation of smart village. We break down this objective into three research questions: (1) How does smart village implemented in the study regions, and to what extent the practice different each other?; (2) What variables influence the features of Smart Village applications in the study areas?; and (3) How do these factors influence the characteristics of Smart Village?

Research Method

We employed the descriptive analytic approach to illustrate the governance implications of smart village efforts. We offer examples of smart village development and implementation from two Indonesian villages: Desa Ponggok in Kabupaten Klaten, Central Java Province, and Desa Kuala Sempang in Kabupaten Bintan, Kepulauan Riau Province. We utilized the PESTLE technique to conduct a business analysis on the installation of smart-village technologies in the research locations. PESTLE analysis serves as a strategic planning tool utilized for assessing the influence of political, economic, social, technological, legal, and environmental factors on a project. It entails organizations evaluating the external environment prior to project initiation to gain insights into potential impacts (Rastogi & Trivedi, 2016). This tool is used to solve political (P), economic (E), social (S), technical (T), legal (L), and environmental (E) concerns in optimizing smart villages (Sridhar et al., 2016;

Zalengera et al., 2014). The comparative approach is based on the assumption that, while smart-village has a high potential to help village development, its implementation will be determined by the characteristics of the village itself, as well as the larger political-economic-social framework. We chose these two villages as examples of comparative research as they have distinctive social-geographic backgrounds. Desa Ponggok is located in the main island of Java, which is renowned as Indonesia's development core. In comparison to the other islands, Java is the most populous and developed. Desa Ponggok is additionally known as the village with the greatest village revenue in Indonesia, derived from tourism and natural resources (spring water). On the other hand, Desa Kuala Sempang is located in Kepulauan Riau Province, close the Indonesia-Malaysia border. Given that these two villages have diverse social, demographic, and geographical characteristics, we suggest that this can produce given the differences in social-demographic-geographic characteristics of these two villages, we believe that this can provide substantial insight into how technology deployment is heavily influenced by other social-political-economic factors.

We conduct data collections through literature study and interviews. Literature study was conducted to get an overview on the implementation of smart-village, from preparation, system development, implementation, and monitoring-evaluation stages. We also conduct interviews with key stakeholders to validate and reinforce the findings of the literature study. The interviewees included officials from the Village Government and the community, who are the primary consumers of smart-village apps. We next use the PESTLE approach to categorize our data for further investigation.

Result and Discussion
Contextual Background of the Implementation of Smart-Village in Indonesia

In Indonesia, a village is the smallest administrative unit subject to independent development (Trilaksono & Sukartini, 2020). Nonetheless, villages confront a wide range of development obstacles. Some of the issues confronting villages include poverty and inadequate infrastructure (Gultom, 2021; Kurniawan, 2021). This legislation grants villages the authority to govern their affairs and communities based on their socio-cultural values. Subsequently, this was followed by Government Regulation Number 60 of 2014 concerning Village Funds. These village funds are intended to finance governance, development, as well as community empowerment and development. In line with this, to measure the level of village development, the government established the Village Development Index (VDI), comprising five dimensions: basic services, infrastructure conditions, accessibility, public services, and governance (Trilaksono & Sukartini, 2020). Thus, it can be understood that village development in Indonesia is aimed at realizing advanced and self-reliant villages, leveraging their potential in accordance with their respective characteristics.

In accordance with this, the Minister of Home Affairs issued Ministerial Regulation Number 3 of 2017 on Guidelines for the Management of Information and Documentation

Services of the Ministry of Home Affairs and Local Governments. This legislation strives to establish open and responsible government by managing and providing high-quality information-documentation services at all levels, from the central to the village. Furthermore, the legislation requires the installation of Village Information and Documentation Management Officers (PPID) at the village level. This implicitly shows the need for a village information system (Hernandi et al., n.d.).

In the context of village development, the synergy between Ministerial Regulation of Home Affairs (Permendagri) with the Village Law (UU Desa), Village Fund Government Regulation (PP Dana Desa), and the fulfillment of Village Development Index (VDI) signifies that a village information system supported by information and communication technology is crucial in realizing advanced and self-reliant villages. This gradually paves the way for the emergence of the smart village concept in Indonesia.

Smart villages are one potential village development approach to address these issues (Hadian & Susanto, 2022). In Indonesia, the concept of a smart village consists of eight components: economy, information and communication technology (ICT), human resources, governance, environment, tourism, agriculture, and energy resources (Hadian & Susanto, 2022). In this context, the ICT component plays a crucial role in the realization of smart villages. According to Munir (2017) and Ramesh (2018), this is largely because smart villages are broadly defined as communities that innovatively employ information technology to improve quality of life and competitiveness in economic, social, and environmental areas (Herdiana, 2019). This is reinforced by the issuance of Minister of Village Regulation Number 7 of 2021 concerning the Prioritization of Village Fund Utilization for the Year 2022, which emphasizes the prioritization of village fund usage for village data collection, potential and resource mapping, as well as information and communication technology management to expand partnerships for village development. These aspects demonstrate that the ICT component is an integral part of smart village development/realization.

On the other hand, village governments and their communities also constitute fundamental components for the realization of smart villages. When linked to ICT, the concept of smart villages is understood as the integration of information technology into rural community life to generate benefits and sustainability through the synergy between ICT and rural communities (Herdiana, 2019). It is reported that within 2015 – 2020, the government has been allocated for IDR. 329,65 trillion for Village Fund *(Dana Desa),* one of which is used to develop smart village initiatives. In the 2020-2024 period, the government has also targeted 3000 villages to enter the smart village program. The entirety of these aspects indicates that smart villages in Indonesia are developed based on the synergy between potential, community empowerment, and village governance, driven by ICT, in efforts to achieve advanced and self-reliant villages.

Overview of the two study area

In this section, we delineate smart village initiatives undertaken in both villages. As previously elucidated, these two villages possess distinct geographical-demographic characteristics and socio-economic profiles. Ponggok Village, situated in the Klaten Regency of Central Java, falls within the category of Developed Village. Renowned for its abundant water resources, it serves as the primary source of income for the village, facilitated by private sector investments in the mineral water industry. Additionally, Ponggok Village is acclaimed for its water tourism, garnering popularity as a tourist destination at both national and international levels. Indeed, in the year 2020, Ponggok Village attained the highest Village Income (PAD) in Indonesia, amounting to IDR 14 billion annually. The management of these ventures is entrusted to the Village-Owned Enterprise (BUMDES) Tirta Mandiri, which oversees both the water resources and tourism sector. The village's revenue is reinvested into the development of infrastructure, tourism, and human resource enhancement to bolster community welfare.

A notable flagship program of the village government is the establishment of scholarships for one member per family (One Family One Graduate). Using Village Income (PAD), the village government grant scholarship of one of each member of a family. Owing to its success, Ponggok Village has emerged as a benchmark for BUMDES management in Indonesia. Complementing this achievement is the establishment of a Village Training Center, serving as a knowledge hub for other villages nationwide on effective village resource management. This initiative has attracted numerous villages seeking to undertake comparative studies in this domain. Such endeavors align with Ponggok Village's vision and mission to realize self-sufficiency, sustainable village potential management, and development.

Meanwhile, the second village, Kuala Sempang, situated in Seri Kuala Lobam Subdistrict, Bintan Utara District, Bintan Regency, Riau Islands Province. This village emerged from the subdivision of Busung Village in Bintan Utara District, as ratified by Regional Regulation No. 8 of 2005 of the Riau Islands Regency. Kuala Sempang Village boasts agricultural and marine fisheries potential, along with beach tourism, albeit not yet fully optimized. Presently, Kuala Sempang Village's primary priorities include the establishment of professional governance, human resource development, and enhancing community capacity and participation across various developmental domains such as education, health, economy, social affairs, religion, and culture through empowerment programs. In contrast to Ponggok Village, Kuala Sempang Village lacks significant income potential. The primary sources of village revenue stem from the agricultural and fisheries sectors. However, the magnitude of this income is not as substantial as that observed in Ponggok Village. The location of study sites is depicted in figure 1.

Assessing their geographical and socio-demographic profiles reveals stark differences between the two regions. Ponggok Village is situated on Java Island, known for its highest economic growth rate and developmental activities in Indonesia. Conversely, Kuala Sempang

Village is in the Riau Islands, an area proximate to border regions of Indonesia. Geographically, Ponggok Village has closer access to growth centers, facilitating access to specific resources such as human resources, technological adaptation, and higher governmental authorities compared to Kuala Sempang. This observation aligns with the notion that regional disparities are influenced by geographical factors, as posited by (Cooper et al., 2022).

Furthermore, these villages have different growth tendencies. Ponggok Village's principal commodity is tourism and water resource management. On the other hand, Kuala Sempang Village, like other typical Indonesian villages, generates money from agriculture and marine fisheries. These inequalities result in diverse developmental program orientations. Ponggok Village prioritizes infrastructure development that supports agriculture sectors and the growth of micro, small, and medium-sized companies (MSMEs) that goes in line with tourism business, whereas Kuala Sempang Village concentrates on infrastructure development and agricultural activities.

Figure 1. Study Area

Smart-Village Application: A Comparison between Two Villages

Both smart village efforts are spearheaded by the village government, with great influence exercised by village leaders to make their efforts succeed, albeit with significant backing from other government members. Both communities are equally enthusiastic about accomplishing these smart village projects, which aim to encourage village development geared toward sustainability while also implementing efficient land administration via the use of Information and Communication Technology (ICT). In both circumstances, village leaders state that ICT support may help to administer village region in accordance with openness, efficiency, and accountability principles, hence improving village government performance. For example, they use smart village channels to increase public information openness and

make information and documentation management easier. Furthermore, both communities use similar avenues to promote community involvement, but with different emphasis. For example, the smart village application in Ponggok Village allows local community to recommend the distribution of village funds as input for the village development plan. Another feature of Ponggok Village allows locals to use these channels to promote their business ventures (goods and services) to a broader marketplace. In contrast, community engagement in Kuala Sempang Village is primarily focused on including people in the monitoring and evaluation of public infrastructure and social services, such as giving real-time reporting on road conditions, irrigation, and other public amenities. Hence, we argue that Ponggok Village has a larger user base than Kuala Sempang Village, owing to its vested interest in tourist development, which is one of its key commodities, along with management of water resources that become the main commodity of this village.

Nonetheless, we note that the decision as to which module of the smart-village application becomes the primary emphasis, as well as the data incorporated into the system, is highly impacted by the village's characteristics. Ponggok Village, for example, with its significant natural resources and tourism business potential, focuses on supporting micro, small, and medium-sized enterprises (MSMEs) to boost the tourism sector, as well as transparent and accountable village fund management. Ponggok Village's smart village application includes an online inventory of tourist profiles and locations, as well as supporting facilities such as MSMEs distribution and other tourism amenities. Meanwhile, Kuala Sempang Village focuses more on rural infrastructure development, such as monitoring road networks. Furthermore, considering the importance of agriculture in Kuala Sempang, the program enables the optimization of agricultural management and other village potentials such as crop rotation and irrigation data. This is understandable given that Kuala Sempang Village is a growing village that requires infrastructure development to sustain its economy, as opposed to Ponggok Village, which is well-established and generates significant village revenue through the management of village-owned enterprises (BUMDES). We see that the key aspects of the smart village application in these communities are heavily impacted by their vision and goal. Ponggok Village concentrates on improving the tourist and small business sectors, whereas Kuala Sempang Village principally intends to enhance infrastructure and other services while also supporting agriculture. This is also visible in the thematic maps facilitated by the system, which are customized to match the unique needs of each village.

In terms of land management, both villages share similarities in utilizing parcel-based maps to record and map land parcels within their respective areas. The provided information includes tenurial data, such as land ownership and land use, along with tenurial history and land transaction details. Both systems also enable village officers to update land boundaries through on-screen digitization in the event of land transactions. Additionally, the systems offer maps of village administrative boundaries, which remain a critical issue in Indonesia to date (Sari, 2019). While determining village boundaries requires stronger legal instruments,

these systems can serve as preliminary initiatives in delineating village boundaries. An overall comparison between the two systems is presented in Table 1.

Table 1. Overview of the Implementation of Smart Village

No	Aspect	Description	Desa Ponggok	Desa Kuala Sempang
1	Initiatives	From whence does the initiative for Smart Village application originate	Village leader	Village leader
2	Source of funding	Source of funds used for system development	Village revenues from village-owned enterprises (BUMDES)	Village fund (state's budged)
3	Main user	Stakeholder who mainly use the system	Village government Local community Wider society	Mainly village government
3	Support good governance	The ability of the system to support good governance practices, such as openness of public information, management of data and information	Yes	Yes
4	Community participation	The ability of the system to provide channels for community participation	- Feature to submit proposal for village development program - Feature to advertise small business enterprise for the community (goods and service)	- Real-time report on road facilities condition
5	Support village's vision and mission	The ability of the system to facilitate the achievement of vision and mission	- Tourism - Natural resource management - Promote Community's Small Enterprise	- Agriculture - Infrastructure development
6	Support land record data and administration	The ability of the system to provide parcel-based land data, as well as to update any physical and legal history of the land.	Yes	Yes

Source: Data analysis

Using PESTLE Analysis to Understand the Implementation of Smart Village

We utilize the PESTLE analysis tool as a foundation for comprehending the implementation of the Smart Village initiative in two project areas. Our objective is to discern the disparities between the two initiatives, identify the factors contributing to their distinctiveness, and assess how these variations impact the overall outcomes of the Smart Village initiatives. This analytical framework enables us to delineate differences across each category, thereby facilitating a focused analysis and elucidating the key factors that significantly influence the implementation of the Smart Village initiative.

Political: Political factors primarily determine the extent to which a government can influence specific initiatives. At the national level, historically, the Smart Village initiatives in both regions share the same origins – it was triggered by government policies to establish the 100 Smart Cities program initiated in 2017. The initial initiation of the program involved agreements with 24 regencies and cities to implement smart city initiatives, beginning with the development of smart city masterplans and quick win within the year 2017-2019. Over time, the Smart City program has expanded, with an increasing number of cities and regencies adopting the concept.

The concept of Smart Village itself initially emerged in 2016. However, it was not until 2018 that the Ministry of Villages, Disadvantaged Regions, and Transmigration began developing the Smart Village concept. The early development of Smart Village initiatives was originally aimed at supporting the implementation of Smart Cities. The government also targeted the realization of 3000 Smart Villages in Indonesia by the year 2024. This government agenda subsequently accelerated the initiation of Smart Village initiatives in Indonesia, including in the two study areas.

Although the initial emergence of smart villages in Indonesia was initiated by central government policies (centralization) with the target of establishing a certain number of 3000 smart villages, at the village level, the implementation of smart villages shifted towards decentralization. In this regard, villages are autonomously empowered to determine their development direction according to their characteristics or potential. This policy of developing smart villages at the local level enables the utilization of information and communication technology to provide a comprehensive overview of the village and all its potential in supporting development. It is within this context of autonomy that the quality and sustainability of smart villages can be identified. Smart villages are not solely assessed based on their quantity but also on their quality.

The implementation of a smart village development policy at the local level enables synergy between the village government and its community in determining the direction of village planning and development. Here, smart village development is understood as a condition that demonstrates grassroots initiatives, originating from the community, aimed at identifying potential and enhancing their capabilities. On the other hand, the village government plays a role as a facilitator in realizing the improvement of the quality of life for the community (Herdiana, 2019).

Here, considering its local policy characteristics, Kuala Sempang Village tends to opt for inward/self-improvement policies. The village government and community choose the direction of smart village development to strengthen existing potential (agriculture and fisheries) and to benefit from improvements in government services and accountability. On the other hand, Ponggok Village tends to choose outward/expansion policies. The village government and community select the direction of smart village development to gain profit through the development of tourism industry and community-owned small businesses, while not neglecting the aspect of good governance.

Economic: This factor serves as a determinant of economic performance that directly influences enterprises and yields lasting repercussions. In this study, we ascertain that economic factors emerge as the primary driver in the implementation of the Smart Village initiative in Ponggok Village. As previously delineated, Ponggok exhibits significant economic potential, evidenced by its capacity to enhance the welfare of its residents. The management of the Tirta Marta Village-Owned Enterprises (BUMDES), serving as the primary business unit in Ponggok, necessitates transparent, accountable, and reliable governance. Hence, the utilization of application features within the Smart Village framework serves as a platform to achieve these objectives, aligning with one of its functions—promoting good governance.

Additionally, another supportive factor is the village's orientation towards developing its tourism industry and promoting the small enterprises owned by its community, both of which are accommodated within the developed Smart Village application. Leveraging ICT for promotional purposes is anticipated to extend market reach, particularly in the realm of tourism, thus serving as a valuable promotional platform for the village's tourism industry.

Conversely, Kuala Sempang Village lacks the substantial economic potential observed in Ponggok Village. Consequently, the Smart Village application implemented in Kuala Sempang is primarily directed towards village administration management and fostering good governance. Nevertheless, the design of the Smart Village application also aims to support the agricultural sector, which serves as a principal commodity in Kuala Sempang, although its practical utilization is less than optimal. Supplementary features for the agricultural sector include irrigation distribution maps and crop rotation guidance.

Social: This factor encompasses all social dimensions that influence both the project, and the community involved. Hence, it is crucial to consider the advantages and disadvantages to the local population where the projects are being implemented. In both study areas, we identified similar social aspects shaping the overall design of the Smart Village application. Both villages emphasize the importance of community participation and engagement at every stage, ranging from preparation, planning, design, to implementation. While the primary initiative originates from village leaders, community involvement is paramount in its execution, allowing for application design adjustments according to the needs and aspirations of the community.

Furthermore, given that one of the primary objectives of the smart village application is to enhance transparency and accountability, features facilitating documentation

management and public information play a pivotal role in both villages. This aligns with the principle of ICT application in public service delivery (via e-government), serving as a communication platform between government bodies and various stakeholders, including the private sector and the community (Finger & Pécoud, 2003; Schelin, 2007).

To further underscore the importance of public participation in the implementation of the Smart Village initiative, we also observed that both applications provide avenues for interaction with the community. While in Ponggok Village, this is primarily directed towards business enterprises (where community members can advertise their businesses by inputting information directly into the system), in Kuala Sempang Village, community involvement leans towards their participation in monitoring and evaluating public and social facilities. This is facilitated through interactive and real-time reporting menus for road and bridge facilities. This difference is predominantly driven by the differing economic characteristics of the communities in the two villages.

Technological: This component pertains specifically to technological innovations that may influence the project's implementation. It encompasses automation, research and development, and the level of technological awareness within the community. We argue that the Smart Village initiative itself demonstrates the local government's (village government) awareness of the importance of adapting and implementing ICT for achieving good governance. However, the utilization and optimization of technology for decision-making processes, improving economic, social, and environmental conditions, and supporting sustainable development pose significant challenges (Ella & Andari, 2019; Thadaboina, 2009). These challenges include human resources, data maintenance, and updates, which are also linked to the village's financial resources. Sustainable development of the application system also requires maintenance to ensure its reliability. Particularly in land information, continuous updates regarding spatial information and attributes are necessary, as land transactions occur continuously, necessitating system updates. Similarly, thematic information presented in the village's thematic map feature requires periodic updates. Therefore, in addition to personnel proficient in information technology, expertise in basic measurement and mapping is also required for data maintenance purposes.

Another challenge faced in both study areas is the engagement of the community as users to optimally utilize the system. As mentioned earlier, the two systems are designed based on the needs and aspirations of the community, with one of the objectives being to enhance community participation and improve quality of life. This can be achieved through user engagement, which is determined by the level of ICT literacy within the community. Considering the diverse characteristics and backgrounds of rural communities, their mastery of information technology varies, necessitating greater efforts from village governments to enhance user engagement with the Smart Village apps. Socio-cultural issues, cultural and educational barriers, and technological discrimination are some of the issues that must be addressed to optimize the function of the Smart Village (Ashraf et al., 2009).

Legal: This component takes into consideration all legal aspects that relate to the implementation of Smart Village initiatives. In this context, there are at least three types of legal aspects serving as references for both villages. Firstly, the legal aspect related to the realization of smart villages. The legal framework underpinning the realization of smart villages is outlined in Law Number 6 of 2014 concerning Villages (Law No. 6 of 2014). Although the concept of smart villages is not specifically mentioned, this law embodies the essence of smart villages through its provisions regarding village development autonomy. Law No. 6 of 2014 provides a legal framework for each village to plan and develop its potential in the context of village development.

Secondly, the legal aspect related to the concept of smart villages. The integration of Information and Communication Technology (ICT) with village life is grounded in Minister of Village, Disadvantaged Region Development, and Transmigration Regulation Number 7 of 2021 concerning Priority Uses of Village Funds for the Year 2022, particularly in Article 6 paragraph (2) letter a (Ministerial Regulation No. 7 of 2021). Ministerial Regulation No. 7 of 2021 provides a legal framework for ICT management to realize village development.

Thirdly, the legal aspect related to water resources management. Kuala Sempang Village and Ponggok Village share the same natural resource, which is water. Kuala Sempang Village has marine water resources, while Ponggok Village has spring water resources. The presence of water resources closely tied to the environmental conditions of an area results in interconnectedness and ecological interdependence of water availability and quality across administrative boundaries. This necessitates coordination with other water resources management sectors, and it is plausible that each sector may have different legal frameworks. The entirety of the legal aspects serves as references and considerations for the development of ICT/applications in realizing smart villages in Kuala Sempang and Ponggok.

Environmental: This component encompasses factors influenced by the surrounding environment, including climate, weather, geographic location, and other related components. Numerous studies have linked geographic location to regional disparities (Cooper et al., 2022), including in the context of ICT adaptation (Milicevic & Gareis, 2003)(Pick et al., 2018). However, the extent to which the Smart Village apps are utilized by a broader user base (the general public) goes beyond the scope of this research. Nonetheless, we observed that in both villages, the primary users of the application are village governments, particularly to support administrative governance.

Table 2. PESTLE Analysis for the Implementation of Smart Village

Aspect	Ponggok Village	Kuala Sempang Village
Politics	Both are driven by central government policies. However, they have different characteristics in developing their local politics. Ponggok tends to develop outward expansion, while Kuala Sempang tends to develop an inward expansion.	
Economic	Economic interest to support tourism and tourism-business related become the main drivers.	Particularly to support agriculture

Social	Community participation is mainly related to tourism-related business.	Community participation is mainly related to monitoring and maintenance of public infrastructure.
Technological	Both villages face the same challenges on the implementation: - Community engagement to optimize the implementation into broader scope. - ICT culture and environment, as village community has broad range of experience, culture and awareness in adaptation of ICT	
Legal	Both Villages have the same driver from national level (through Village Law and Village Fund Law) but then both villages developed its ICT adaptation based on their own characteristics and has been further regulated in local regulation.	
Environmental	Both villages face the same challenges to optimize the implementation of Smart Village that goes beyond administrative governance.	

Source: Data analysis

Conclusion

Smart Village initiatives offer numerous benefits to rural communities, notably in fostering good governance practices at the village level. However, villages, serving as the smallest representatives of local government, exhibit diverse geographical, demographic, social, economic, and cultural characteristics. The implementation of Smart Village entails more than merely adopting technology and utilizing ICT for daily needs; it also involves realizing the dimensions of smart village encompassing smart governance, smart society, smart economy, smart branding, smart living, and smart environment. Moreover, the implementation of Smart Village initiatives should be tailored to suit the specific needs of each village, aligning with its unique characteristics.

Our findings confirm that the design and implementation of Smart Village initiatives differ between the two study areas, with economic and social factors emerging as the primary distinguishing factors. In the case of Ponggok Village, tourism and water resource management are predominant in determining the design and functionality of Smart Village, whereas Kuala Sempang Village emphasizes infrastructure and agriculture sectors, which serve as their main sources of income. Additionally, Ponggok Village places emphasis on promoting and supporting SMEs, while Kuala Sempang Village focuses more on community participation in monitoring public facilities and social amenities. However, both villages face similar technological challenges regarding fostering ICT culture and awareness among the community, thereby enabling broader outreach and optimizing utilization to achieve all dimensions of Smart Village initiatives.

Furthermore, we propose that the development of Smart Village initiatives should also consider their sustainability. System maintenance and data updating are critical aspects to be considered for sustainability, ensuring that the system can continue to provide up-to-date and reliable information. We also recommend enhancing community participation to ensure

that the designed systems yield optimal results. This applies to the maintenance of land parcel data as well, ensuring that parcel-based information is updated and remains reliable.

Additionally, we did not investigate the extent to which smart village initiatives promote good governance and benefit the community in the long term, which was a limitation of this study. Nevertheless, we propose that future research that concentrates on the influence of smart village initiatives will be advantageous for the further evaluation and enhancement of the initiative.

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