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Research Article [OPEN ACCESS]

Developing a Reference for Smart Rural Communities: An Enterprise Architecture Perspective for Smart Governance

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ABSTRACT

The digital transformation of rural governance is critical to achieving Sustainable Development Goals (SDGs) and fostering community self-reliance. This study develops a comprehensive Enterprise Architecture (EA) framework tailored for smart rural communities using the TOGAF 9.2 methodology. The framework integrates business, data, application, and technology architectures to address inefficiencies, enhance transparency, and optimize governance processes in rural Indonesia. The research adopts the Design Science Research Methodology (DSRM) to ensure systematic artifact development and alignment with strategic goals. Key outcomes include improved administrative services, asset management, and community engagement, demonstrated through case studies involving systems such as SIMIDES, SISMANDES, and OpenSID. The proposed EA framework directly contributes to enhancing Village Development Index (IDM) scores, supporting SDGs like poverty alleviation, quality education, and reduced regional disparities. While the framework presents a scalable model for rural governance, challenges such as IT infrastructure limitations and stakeholder readiness remain. Future research should explore the integration of emerging technologies like IoT and AI to further enhance the model's adaptability.

Keyword: Enterprise architecture, smart rural communities, TOGAF 9.2

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1. INTRODUCTION

The digital transformation era has positioned Information Technology (IT) as a critical driver across numerous sectors, including rural governance. In Indonesia, the introduction of e-government initiatives marked a significant transition towards modern governance (Herdiana, 2019). E-government is strategically defined as the utilization of IT to enhance government operations, structures, public participation, and essential functions (Twizeyimana & Andersson, 2019). At the rural level, the concept of "smart villages" has emerged, aiming to leverage IT to improve governance and quality of life (Rokhman, 2023). This framework is built upon six pillars—Smart Governance, Smart Society, Smart Environment, Smart Living, Smart Mobility, and Smart Economy—all of which contribute to fostering sustainable and efficient rural communities (Aziiza & Susanto, 2020).

The success of smart rural initiatives is evident in enhanced governance performance across various regions. Research by Alhari & Fajrillah (2022) highlights that these initiatives have significantly improved operational efficiency, particularly in the domain of smart governance. Additionally, these advancements play a crucial role in supporting Sustainable Development Goals (SDGs) within rural areas (Chaudhary, 2023).

To evaluate the progress of village development, the Indonesian government employs the Village Development Index (IDM). This index measures village self-reliance and development based on a range of indicators (Prasetyo & Sonny, 2020). Despite various efforts to enhance village self-reliance through IT, significant gaps remain. By Q3 2024, only 23.86% of villages are projected to achieve "independent" status as per the IDM, underscoring the need for optimized IT utilization in village (Tim Kementerian DPDTT, 2024).

Table 1. Classification of villages by development level in quartil 3, 2024

Classification of Status	Number of Village	Precentage of Village
Independent	17,150	23.86%
Developed	22,943	31.92%
Developing	24,100	33.53%
Disadvantaged	5,301	7.38%
Extremely Disadvantaged	2,374	3.30%

The data in Table 1 indicates persistent gaps in achieving village independence, largely due to the suboptimal application of IT in administrative services and information dissemination. Addressing these gaps requires a comprehensive framework to enhance village performance.

The implementation of smart village concepts provides a viable solution for optimizing IT use in rural governance (Huda et al., 2020). A critical tool for bridging these gaps is Enterprise Architecture (EA), which aligns governance goals with technology (Boucharas et al., 2010; Imanudin et al., 2022). The EA framework TOGAF 9.2 is particularly suitable, as it facilitates structured and integrated architectural planning, enabling the effective coordination of various systems and processes within rural governance (Jannah et al., 2024).

2. MATERIALS AND METHODS

2.1 Materials

Smart Rural refers to the integration of innovative solutions powered by Information and Communication Technology (ICT) to enhance the quality of life in rural areas (Ella & Andari, 2019). Distinct from urban-focused smart city initiatives, Smart Rural prioritizes the development of local resources and sustainable planning while fostering a knowledge-based economy (Bielska et al., 2021). This approach is grounded in five core principles: efficiency, participation, inclusiveness, innovation, and collaboration. These principles aim to drive advancements in critical areas, including education, health, economy, sanitation, energy, and participatory democracy (Park & Cha, 2019). By leveraging digital technologies, Smart Rural addresses unique challenges faced by rural communities, such as limited access to essential services, economic opportunities, and infrastructure. It ensures rural areas are active participants in the ongoing digital revolution, preventing their marginalization in an increasingly technology-driven world (Munawar et al., 2023).

The implementation of Smart Rural significantly contributes to achieving Sustainable Development Goals (SDGs) in rural contexts, particularly in poverty alleviation, improving education quality, and reducing regional disparities. A key metric for assessing rural development in Indonesia is the Village Development Index (IDM), which evaluates village performance across three primary dimensions: Social Resilience Index, Economic Resilience Index, and Environmental Resilience Index (Astika & Subawa, 2021). Strengthening the pillars of Smart Rural through IT-based management offers a pathway for improving IDM scores and advancing village self-reliance. Enhanced village performance, in turn, supports broader development goals. Table 2 illustrates the interconnections between Smart Rural initiatives, SDGs, and IDM dimensions.

Table 2. Linkages between smart rural, sdgs, and idm

Concept	Definition	Relationship to Smart Rural	Example Implementation	Measeurement through IDM
Smart Rural	A rural that utilizes technology to improve quality of life	Technology as a tool to achieve SDGs	Smart agriculture, digital health, online education	Increase in economic and social indices
SDGs	17 global goals for sustainable development	Smart rural as a strategy to achieve SDGs	Poverty reduction, clean energy, quality education	All dimensions of IDM (economic, social, infrastructure)
IDM	Index measuring rural development	Benchmark for smart rural success	Increase in overall index value	All dimensions of IDM

2.2 Methods

This study adopts the Design Science Research Methodology (DSRM) to develop an enterprise architecture tailored for village settings. DSRM was selected for its structured and systematic framework, which facilitates the creation of innovative artifacts. A key advantage of DSRM lies in its iterative evaluation process, ensuring that each artifact design is rigorously assessed, and the results are effectively communicated to stakeholders. This approach enables organizations or communities to align the design outcomes with their strategic goals (Peffers et al., 2007).

The research process follows the DSRM stages, which include: identifying problems and motivating the research, defining the objectives of a solution, designing and developing the artifact, demonstrating its applicability, and evaluating its effectiveness (Mukti et al., 2023). Each stage contributes to a systematic problem-solving approach, as illustrated in Figure 1.

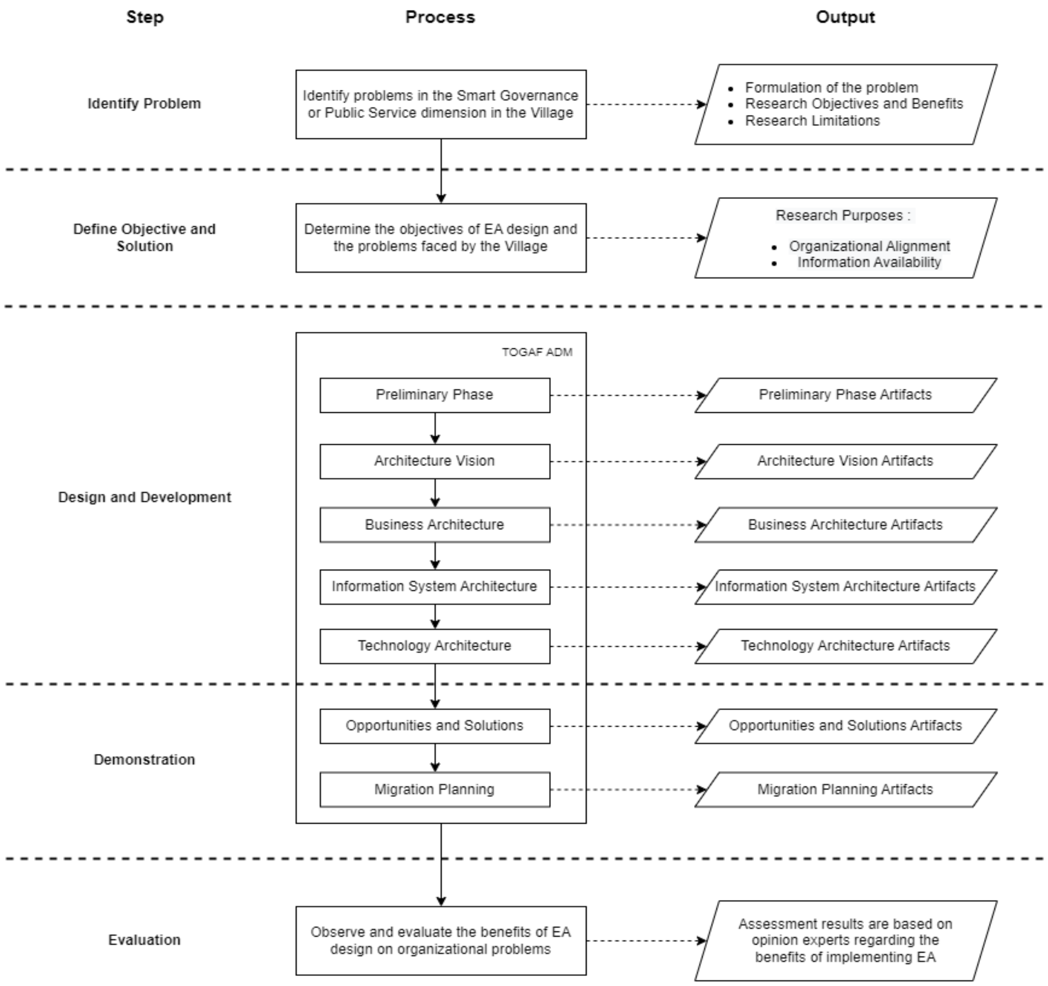

Figure 1. Systematic problem solving DSRM

2.3 Enterprise Architecture

Enterprise Architecture (EA) provides a structured approach to designing organizational architecture with a holistic perspective, encompassing strategy, organizational composition, business processes, departmental collaboration, and information systems (Zhou et al., 2020). EA serves as a critical tool for supporting effective decision-making and planning by aligning organizational goals and needs (Prianti & Papilaya, 2021). The outcome of the EA design process is a comprehensive blueprint, which can guide the migration and optimization of systems within an organization (Endova & Fibriani, 2022).

In the context of Rural Smartness, EA plays a pivotal role in managing the complexity and integration of systems essential for digital transformation in villages (Anthony Jnr, 2021). To facilitate EA design, The Open Group Architecture Framework (TOGAF) is often employed. TOGAF provides a robust framework for designing, building, and managing IT architecture across enterprises (The Open Group, 2018). TOGAF Architecture Development Method (ADM) is a systematic process model that offers a flexible and adaptable set of architecture assets for enterprise architecture development (Dumitriu & Popescu, 2020). This flexibility enables organizations to integrate TOGAF with other frameworks and customize elements of the process to meet specific needs. The approach encompasses business, data, application, and technology layers, ensuring comprehensive coverage of organizational architecture requirements (Kencana et al., 2022).

3. RESULTS AND DISCUSSION

3.1 Preliminary Phase

The preliminary phase plays a critical role as the foundational stage in the architecture design process. This phase establishes the groundwork for designing integrated solutions across business, data, application, and technology domains. By addressing these elements cohesively, the process ensures that the architecture aligns with organizational goals and objectives. The core principles that guide this process are summarized in Table 3, which outlines the fundamental principles across each architectural domain.

Table 3. Principle catalog

Domain	Principles
Business Architecture	• Primacy of Principle • Information Management and integration principles • Realizing good governance • Service Orientation and quality improvement • Business Alignment with IT • Compliance With Law
Data Architecture	• Data is an Asset • Data is Shared • Data Integration • Data Security • Data Valid • Backup database automatic
Application Architecture	• Ease of Use • Flexibility • Application Integration
Technology Architecture	• Maintenance Technology • Interoperability • Change accordingly need • Technology Infrastructure Security • Implementation of technology and application security • Security Clearance

3.2 Architecture Vision

The architecture vision phase serves as a foundational step in formulating the vision for the desired smart village enterprise architecture design. This phase defines the scope, strategic goals, core values, and long-term objectives that will shape the subsequent development of the architecture. A key objective of this phase is to ensure that all stakeholders have a shared understanding of the vision and are aligned with the direction outlined for the Smart Village EA. By establishing a clear and agreed-upon vision, this stage provides a strategic framework that guides the design process and ensures that the resulting architecture meets the collective goals of the community and stakeholders. To further illustrate the strategic alignment and interactions among various components, Figure 2 presents a value chain diagram. This diagram highlights the interconnected processes and value-generating activities that underpin the smart village enterprise architecture design.

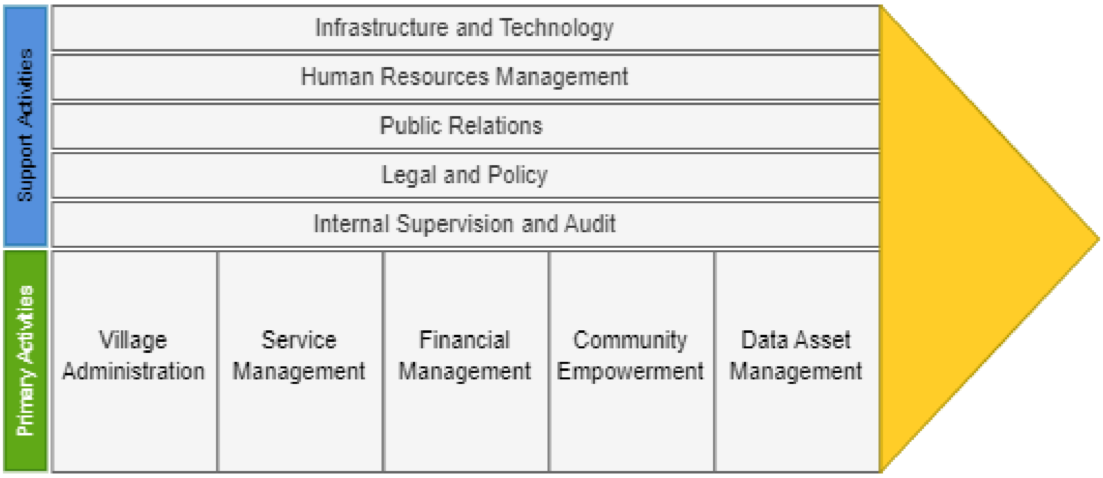

Figure 2. Value chain diagram

3.3 Business Architecture

Village governments face challenges related to inefficiency, lack of effectiveness, and limited transparency in operations. These issues often stem from the absence of system implementation and the underutilization of existing applications. To address these problems, this research identifies three organizational needs, which are classified into system targets:

1. Improving efficiency in village administration processes, such as population management and general administration.
2. Enhancing governance management, including asset management and village development planning.
3. Promoting effective information dissemination and fostering increased community participation.

These organizational needs are visualized in Figure 3 to illustrate their relationships with drivers, objectives, and stakeholders. Additionally, the interactions between key business processes and other architecture domains, such as data, applications, and technology, are mapped in Figure 4.

3.4 Data Architecture

Data Architecture represents the logical and physical structure of an organization's data. It defines the data structure, the relationships between different data entities, and the rules that govern data usage. This architecture ensures that data is well-organized, accessible, and effectively managed. At this stage, a key artifact produced is the logical data diagram, which illustrates the relationships between data entities and their associated attributes. For example, the relationships and attributes specific to the SIMIDES system are illustrated in Figure 5. Similarly, Figure 6 illustrates the logical data diagram for SISMANDES, while Figure 7 illustrates the logical data diagram for OpenSID. Each diagram provides a detailed visualization of how data is structured and interconnected in these systems.

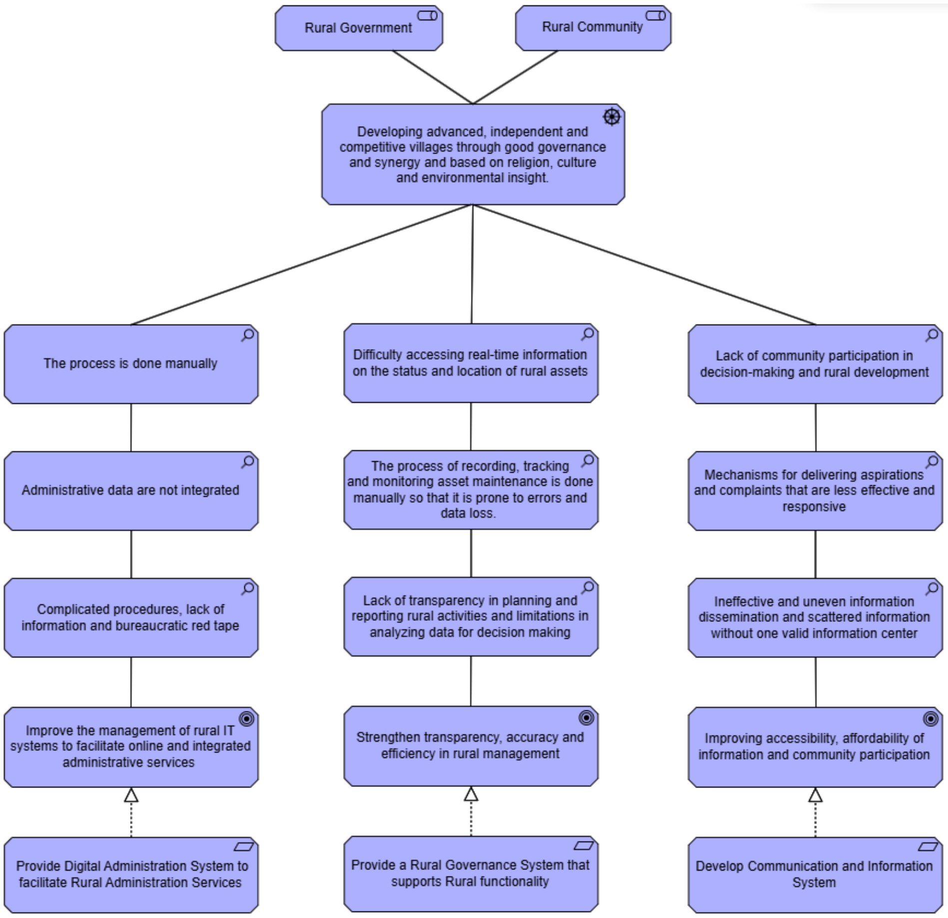

Figure 3. Goal-Objective-Requirement diagram

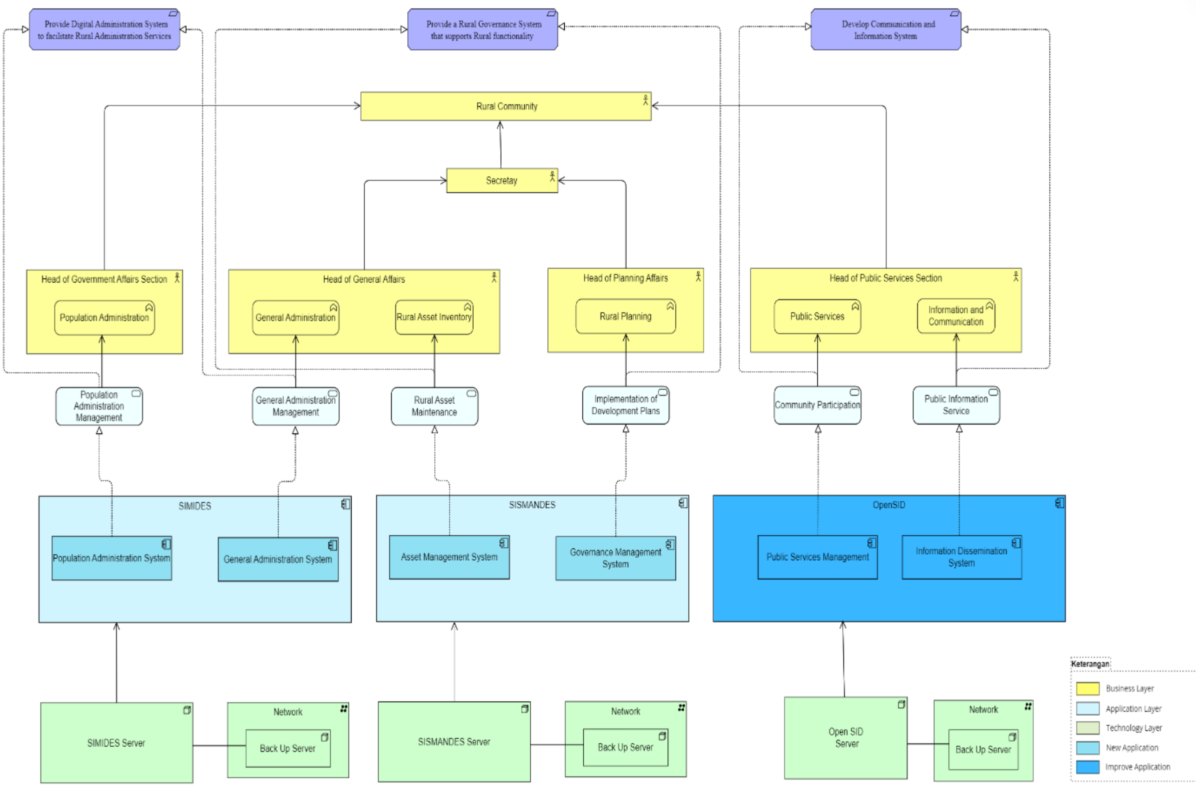

Figure 4. Business footprint diagram

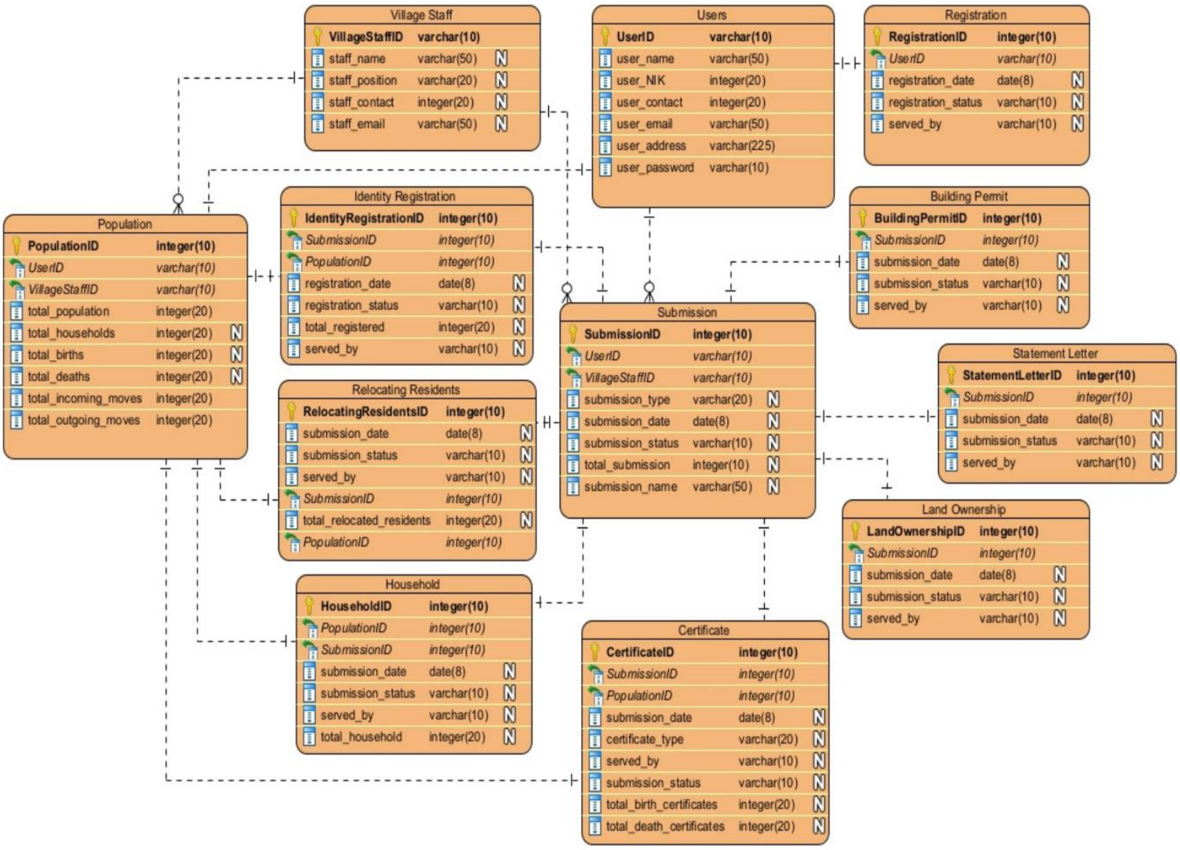

Figure 5. Logical data diagram for SIMIDES

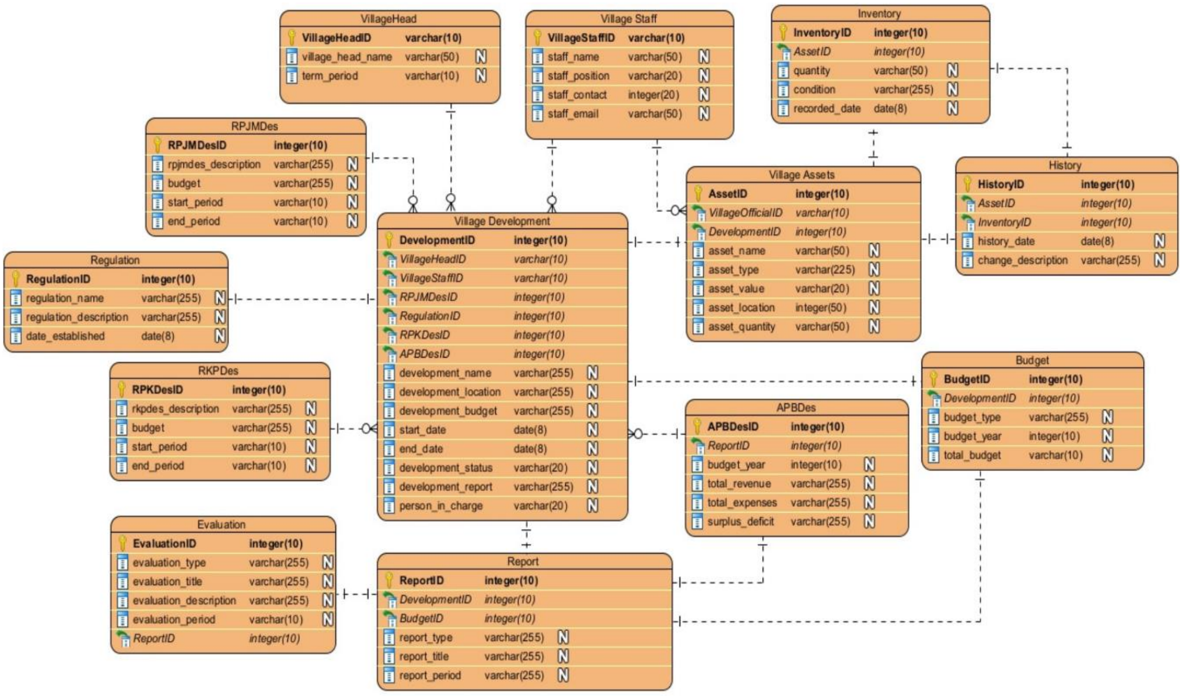

Figure 6. Logical data diagram for SISMANDES

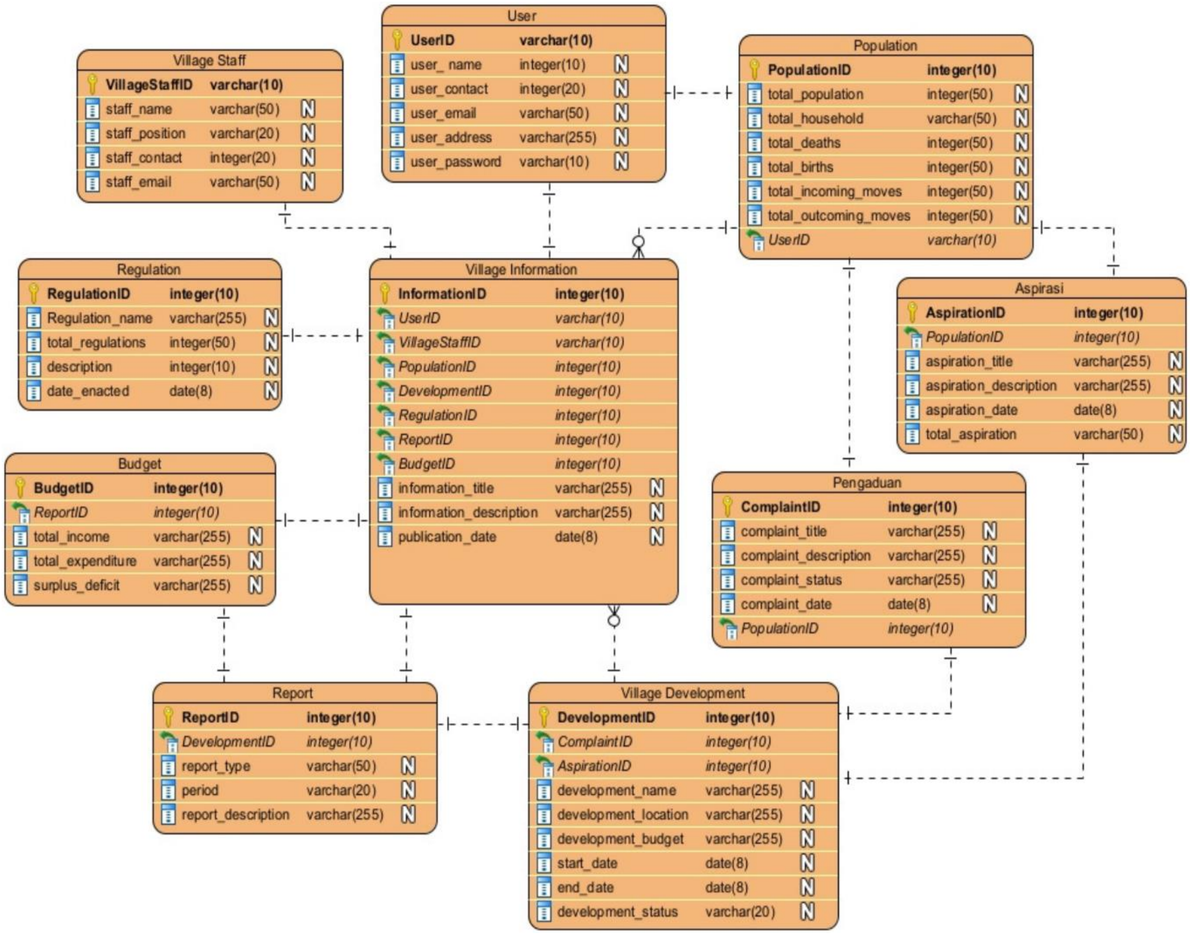

Figure 7. Logical data diagram for OPENSID

3.5 Application Architecture

Application Architecture provides a conceptual framework for understanding the structure and interaction of components within an application system. It focuses on how different applications function and communicate to support organizational needs. Key artifacts produced in this stage include the application portfolio catalog (Table 4), which lists the applications linked to business processes in the village. Additionally, the application communication diagram illustrates the relationships and interactions between application interfaces, showing how they communicate and integrate effectively (Figure 8).

Table 4. Application portofolio catalog

Physical Application Component		Description
Existing	OpenSID	As a platform for disseminating information and increasing community participation in rural governance
Targeting	SIMIDES	Manage population administration and general administration in the rural, including population registration, birth registration, death, displacement, marriage, and other correspondence administration
	SISMANDES	Rural management system to manage rural assets and governance, such as inventory management, development planning, and reporting

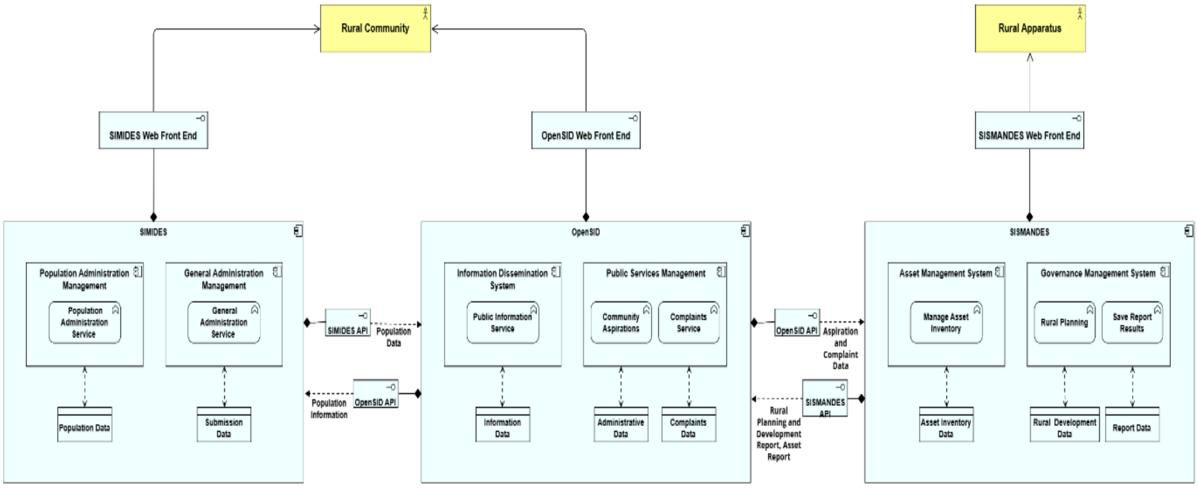

Figure 8. Application communication diagram

3.6 Technology Architecture

Technology Architecture provides a comprehensive description of the technologies employed by an organization to support the development and operation of its applications or systems. This includes hardware, software, networks, and data infrastructure. Technology Architecture serves as a blueprint for guiding the implementation and management of technology within the organization, ensuring alignment with organizational objectives. A key artifact produced in this phase is the environment and location diagram, illustrated in Figure 9, which visualizes the placement and relationships of technology infrastructure components within the organization. This diagram helps identify the location, distribution, and interaction of technological assets, providing a clear perspective for effective planning and management.

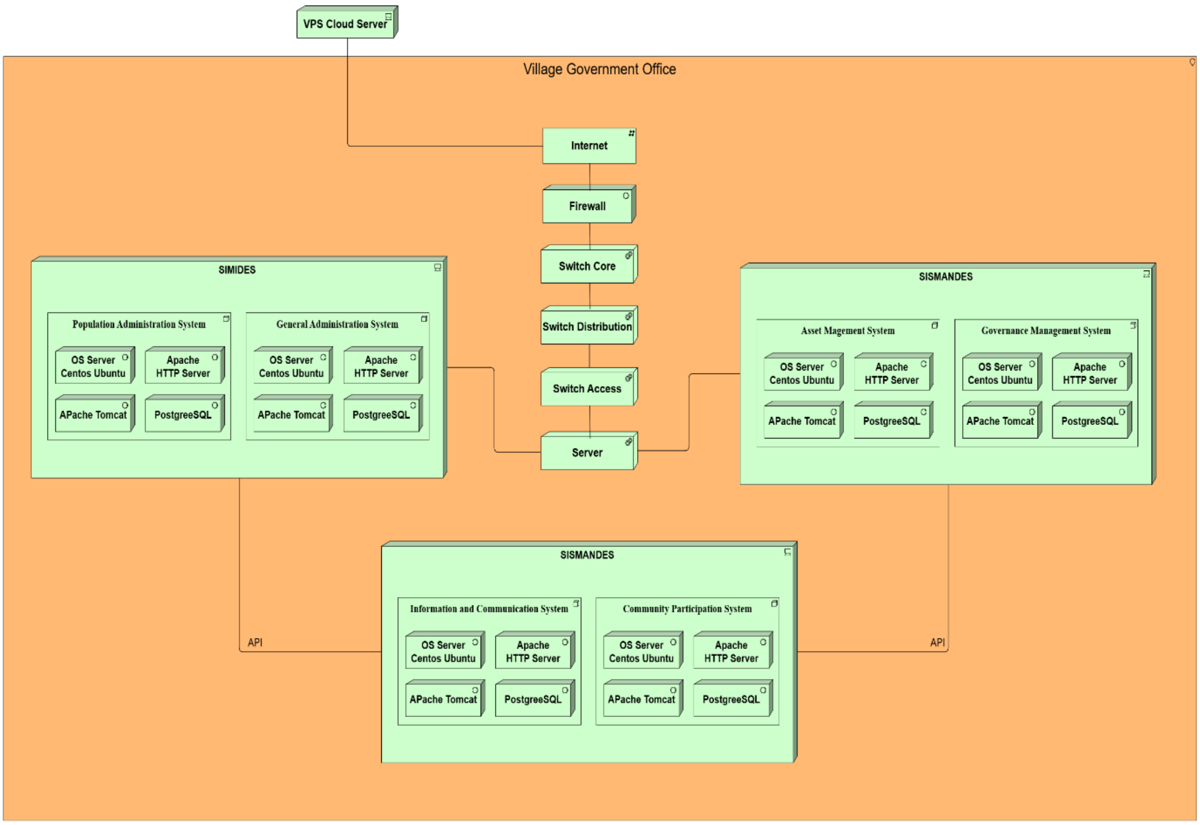

Figure 9. Environment and location diagram

3.7 Discussion

The proposed EA framework aligns closely with the pillars of Smart Governance by addressing challenges such as administrative inefficiency, limited transparency, and ineffective community engagement. This approach complements prior research by Herdiana (2019) and Aziiza & Susanto (2020), who highlighted the transformative potential of IT in rural governance. Unlike existing studies, this framework emphasizes a structured and holistic integration of business, data, application, and technology domains to enhance rural governance efficiency.

The integration of smart rural principles and the Village Development Index (IDM) dimensions directly supports SDGs, particularly in poverty alleviation, education quality improvement, and infrastructure enhancement. The findings resonate with Chaudhary (2023), who demonstrated the role of smart villages in reducing regional disparities. The proposed framework facilitates systematic measurement and evaluation of development outcomes, ensuring alignment with national and global goals.

The implementation of the EA framework, particularly through the TOGAF 9.2 methodology, provides a replicable model for other rural areas aiming to adopt smart governance practices. The case-specific insights derived from systems like SIMIDES, SISMANDES, and OpenSID underline the adaptability of this framework across varying contexts, as suggested by Mukti et al. (2023). This adaptability is crucial in addressing unique rural challenges and leveraging local resources effectively.

4. CONCLUSION

The development of an enterprise architecture to support smart governance in the context of smart rural communities, utilizing the TOGAF 9.2 framework, has resulted in a comprehensive architecture encompassing business, data, application, and technology domains. This design optimizes key business processes, including administration, asset management, development planning, and the management of community aspirations, through the integration of information systems that enhance both efficiency and transparency.

The integration of data across systems facilitates data-driven decision-making, enabling more informed and strategic planning. Additionally, improvements in applications and their development contribute to the digitization of services, ensuring they are more accessible and effective. Enhanced IT infrastructure further ensures technological readiness to support the deployment and operation of the proposed system. Collectively, these advancements provide a strategic foundation for achieving the objectives of smart governance, contributing to the sustainable development of smart rural communities.

This study faces limitations in IT infrastructure availability, stakeholder readiness, and adaptation to emerging technologies like IoT and AI. Future research should address these gaps to enhance the framework's applicability and effectiveness.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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