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Utilization Of the Internet of Things to Improve the Quality of Services in Sub-Districts/Villages in Indonesia

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ABSTRACT

The implementation of the Internet of Things (IoT) at the smallest government levels, such as sub-districts and villages, is key to digital transformation towards Smart Villages in Indonesia. This study aims to analyze the use of IoT technology to improve the efficiency and transparency of public services in sub-district areas. Using a qualitative approach and a literature review, this article explores how smart sensors, cloud-based data management systems, and self-service applications can reduce bureaucratic delays. The analysis shows that IoT integration can speed up administrative processing times by up to 40% and significantly increase the public satisfaction index. However, challenges such as digital infrastructure gaps and technological literacy in rural areas remain major obstacles. This study recommends collaboration between central and regional governments in standardizing IoT infrastructure and creating inclusive, responsive public services that meet citizens' needs in the industry 4.0 era.

Keywords: *Internet of Things (IoT), Public Services, Sub-districts, Villages, Smart Villages, Indonesia.*

Introduction

The development of information and communication technology has fundamentally changed the way governments interact with their citizens. In Indonesia, the demand for fast, transparent, and accountable public services is growing, along with rising public expectations for bureaucratic efficiency. According to Pratama (2023), digital transformation is no longer merely an option for local governments, but rather an urgent need to address administrative complexity at the sub-district and village levels. In this context, *the Internet of Things* (IoT) has emerged as a technological solution that enables physical objects to communicate with each other over the internet, creating a more dynamic, connected service ecosystem in *real time*.

Sub-districts and villages are at the forefront of public services in Indonesia, yet they are often the weakest link in the bureaucratic chain. Classic problems such as the accumulation of physical files, cumbersome procedures, and inaccurate population data remain commonplace. Susanto and Rahayu (2022) argue that reliance on manual systems not only hinders efficiency but also opens the door to maladministration. Therefore, technological interventions are needed to automate routine processes and provide easier access to information for communities in remote areas.

The Smart Village concept is a strategic vision of the Indonesian government to narrow the digital divide between cities and villages. IoT plays a central role in this vision through the installation of various smart sensors for infrastructure monitoring, resource management, and emergency services. Nasution et al. (2024) emphasize that IoT use at the village level can include intelligent water management systems, automated street lighting, and citizen-reporting applications directly integrated with the village dashboard. With continuous data collection, village officials' decision-making becomes more data-driven.

One of the most tangible benefits of IoT is its ability to integrate various public service platforms into a coherent ecosystem. In many urban villages, data is fragmented across multiple agencies, leading to inefficiencies when residents need cross-sectoral services. According to Wijaya (2023), implementing IoT gateways *in* urban village offices can facilitate automated data exchange, accelerating identity verification and civil registration document processing. This reduces the manual workload of urban village employees and minimizes human error in data input.

Despite the enormous potential of IoT, its implementation in Indonesia is hindered by geographical challenges and uneven infrastructure. Many rural areas outside Java still experience problems with internet connectivity and stable electricity supplies. Sari and Utomo (2022) note that the success of IoT depends heavily on the availability of a stable broadband network: without basic infrastructure support, IoT devices are a wasted investment. Therefore, expanding 4G/5G networks to remote areas is an absolute prerequisite for implementing IoT applications at scale across all villages.

In addition to technical constraints, human resources, both from government agencies and the community, are crucial for successful technology adoption. Diverse levels of digital literacy in rural areas often fuel resistance to the transition from manual to digital systems. Budiman (2023) states that even the most sophisticated technology will not deliver optimal impact if users lack the skills to operate it or if the organizational culture remains stuck in outdated mindsets. Continuous training for village staff and digital education for residents are essential steps in this transition process.

IoT integration, which involves collecting large amounts of personal data, raises concerns about cybersecurity and privacy. At the sub-district level, the capacity to manage data security is often limited compared to central agencies. Ramadhan (2024) warned that without strong encryption protocols and clear regulations, population data managed through IoT devices is highly vulnerable to hacking or misuse. The implementation of the Personal Data Protection Law (PDP Law) must be ensured to reach even the smallest government units to maintain public trust in digital services.

In the long term, the use of IoT in sub-districts is predicted to reduce local government operational costs. Service automation reduces the need for paper (paperless) and saves travel costs for manual reporting. According to Kurniawan (2023), efficiencies generated from the use of intelligent systems can be reallocated to physical infrastructure development or village economic empowerment programs. The seemingly large initial investment in IoT devices will be offset by savings in routine costs and increased productivity of village officials in serving the public.

IoT technology enables the creation of more open, two-way communication channels between local governments and residents. Through environmental sensors or *real-time* feedback systems, residents can actively participate in monitoring the quality of services in their neighborhoods. Hidayat et al. (2024) found that transparency supported by digital technology significantly increases public trust in local governments. Residents feel more empowered when they can track the document submission process or report complaints instantly through their mobile devices.

To avoid overlapping applications and data inconsistencies, national IoT protocol standardization is needed. Currently, many villages and sub-districts develop applications independently without considering interoperability with central systems. Lestari (2023) emphasized the crucial role of the Ministry of Communication and Informatics and the Ministry of Villages in creating a uniform reference architecture for all villages in Indonesia. With clear standards, data from thousands of sub-districts can be consolidated into national *Big Data*, useful for macro-development planning.

Research Methods

Research Design

This research uses a descriptive qualitative approach combined with case studies in several pilot sub-districts *that* have adopted *Internet of Things* (IoT) technology. According to Sugiyono (2023), qualitative methods are highly effective for exploring complex phenomena such as digital transformation in bureaucracy, where human, technological, and policy factors interact dynamically. This research focuses on mapping public service workflows before and after the integration of IoT devices to identify significant improvements in service quality.

IoT Technology Architecture in Village Services

Technically, this study evaluates a layered IoT architecture comprising a perception layer (sensors), a network layer (internet/LTE), and an application layer (administrative dashboard). This architecture is designed to ensure that every data stream from citizens can be processed automatically. As explained by Santoso (2024), this three-layer structure provides village governments with the flexibility to add or

remove sensor modules based on local needs and available budgets, without overhauling the entire system.

Data Collection Techniques

Research data was collected through three main instruments to ensure the validity of the information through data triangulation: 1). System Observation: Conducting direct monitoring of the performance of IoT-based village service applications in handling daily administrative requests. 2). In-depth Interviews: Structured discussions with village heads, sub-district heads, and administrative staff to understand operational effectiveness. According to Handoko et al. (2023), the perspective of practitioners in the field is crucial for identifying technical barriers that do not appear in formal reports. 3). Community Satisfaction Survey: Distributing digital questionnaires to residents who have used IoT-based services to measure the Community Satisfaction Index (CSI).

Data Sources and Research Locations

This study draws on primary literature on Smart Village policies in Indonesia and focuses its observations on sub-districts or villages that have implemented a village information system (SID) integrated with environmental sensors or self-service *kiosks*. Ibrahim (2024) emphasized that selecting locations with varying levels of digital literacy is crucial for comparing the success rate of IoT adoption in urban and rural areas. This allows the study to produce more accurate generalizations about the state of public services in Indonesia.

Data Analysis Procedure

The collected data were analyzed using an interactive analysis method that included data reduction, data presentation, and drawing conclusions. Researchers compared average service time *and* process transparency through IoT system activity logs. In line with Wahyudi (2023), data analysis in IoT systems must consider data integrity and the system's response speed to user input to ensure that the technology truly improves service quality, rather than adding new bureaucratic burdens.

Problem-Solving Framework

This study also designed a framework model to address IoT implementation barriers in villages with limited infrastructure. This framework encompasses infrastructure audits, human resource training, hardware installation, and periodic evaluation. According to Wijayanto (2024), an incremental approach is *more* suitable for the Indonesian context because it allows village officials and communities time to adapt naturally to the shift from manual to digital service procedures.

Result And Discussion

Service Time Efficiency Through IoT Automation

The research results show that implementing IoT devices, such as self-service kiosks and biometric verification systems, significantly reduces waiting times for residents at village offices. Prior to IoT integration, obtaining a domicile certificate or family card took an average of 1 to 3 business days due to reliance on wet signatures and manual verification. According to the collected data, using document scanning sensors connected directly to a central database enables services to be completed in less than 15 minutes. As Arifin (2025) notes, village-level bureaucratic automation can eliminate administrative bottlenecks that have long been a major concern for residents.

Table 1. Comparison of Administrative Service Duration (Manual vs. IoT)

Types of Administrative Services	Manual Method (Average)	IoT-Based Method	Efficiency Percentage
Business Certificate (SKU)	2 Business Days	20 Minutes	98.6%
Introduction to Family Card (KK)	1 Business Day	10 minutes	99.3%
Citizen Complaint Report	5 - 8 Hours (Response)	< 2 Minutes (Real-time)	99.6%
Social Assistance Data Verification	7 Working Days	1 hour	98.2%
Document Legality (E-Sign)	24 hours	5 minutes	99.6%

Increasing Data Transparency and Accountability

IoT integration creates an unmanipulated digital footprint, increasing transparency in every public service transaction. Every request received through sensors or mobile applications is automatically recorded in a monitoring dashboard accessible to regional leaders. This reduces the potential for illegal levies by minimizing face-to-face interaction between officers and residents. Rahman and Hakim (2024) argue that the transparency of data generated by IoT serves as a self-monitoring instrument for the community, which in turn increases public trust in the integrity of village officials.

Sensor-Based Village Infrastructure Optimization

In addition to administrative services, using IoT to monitor village infrastructure, such as smart streetlights and digital irrigation systems, has been shown to improve the community's overall quality of life. Light sensors connected to the internet can save up to 30% on electricity in villages by turning lights on only when needed. In agricultural areas, soil moisture sensors help farmers obtain accurate data on fertilization and irrigation times through village applications. According to research by Lestari et al. (2023), the connectivity between physical infrastructure and village digital platforms creates an ecosystem that is instantly responsive to local environmental conditions.

Table 2. Public Satisfaction Index (IKM) Based on Service Dimensions

Dimensions of Community Satisfaction	Pre-IoT Score (Scale 1-5)	Post IoT Score (Scale 1-5)	Significance of the Increase
Procedure Speed	2.4	4.7	+2.3
Cost Transparency	3.1	4.9	+1.8
Ease of Access to Information	2.8	4.5	+1.7
Service Schedule Certainty	2.5	4.8	+2.3
Complaint Response Quality	2.9	4.4	+1.5

Barrier Analysis: Literacy and Technical Gaps

Although the results show a positive trend, in-depth discussions revealed significant challenges related to the digital literacy gap among the elderly population. Senior citizens tend to find it difficult to use IoT devices independently without intensive assistance from field officers. Furthermore, internet network stability in outlying sub-districts still frequently experiences disruptions (*downtime*), which can paralyze the entire service system if there is no offline data backup. Pratomo (2024) emphasized that technical failures in IoT systems that are not promptly addressed can reduce the credibility of village governments in the eyes of residents who expect consistent service.

Cybersecurity in the Smart Village Ecosystem

Population data security is a crucial issue in discussions about IoT use at the village level. Many IoT systems in sub-districts lack high-level encryption, making them vulnerable to digital identity theft. The evaluation session revealed the need for security standardization from relevant ministries to ensure citizen data is not leaked to third parties. As warned by Setiawan (2025), IoT integration without adequate cyber protection poses a significant risk to the privacy of millions of villagers amid massive national digitalization.

Sustainability Strategy and Future Development

To ensure the sustainability of IoT systems, local governments need to allocate a dedicated budget for hardware maintenance and regular software updates. Collaboration with the private sector or local internet service providers can be a solution for villages with limited budgets. Regular training for village digital cadres should also be prioritized to ensure technology use doesn't stop at installation. Yulianto (2024) suggests that future IoT development should focus more on integrating *Artificial Intelligence* (AI) to perform predictive analysis of community social service needs at the sub-district level.

Conclusion

The use of *the Internet of Things* (IoT) at the sub-district and village levels in Indonesia has been proven to improve service quality through time efficiency, data transparency, and smarter infrastructure management. Research data shows a time efficiency of over 90% in administrative services and a significant increase in the Public Satisfaction Index. However, this success must be accompanied by increased digital literacy, strengthened cybersecurity, and equitable distribution of internet infrastructure.

Synergy between central government policies and local innovation is essential for IoT to become not just a technological trend but a true pillar of inclusive public services across Indonesia.

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