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The Strategic Role of Infrastructure and Facilities Management in Enhancing the Quality of Digital Learning Process at SDN 1 Tanjung Lago

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Abstrak

Integrasi Teknologi Informasi dan Komunikasi (TIK) sangat penting dalam pendidikan abad ke-21 untuk mendukung pembelajaran digital yang efektif. Studi ini menganalisis peran strategis dan efektivitas manajemen infrastruktur dan fasilitas (Sarpras) di SDN 1 Tanjung Lago dalam mendukung implementasi pembelajaran digital, serta mengidentifikasi tantangan yang dihadapi. Penelitian ini menggunakan pendekatan kualitatif deskriptif. Data dikumpulkan melalui teknik triangulasi, termasuk wawancara mendalam dengan kepala sekolah, wakil kepala sekolah bidang kurikulum, koordinator Sarpras, dan guru terpilih; observasi partisipan penggunaan fasilitas digital; dan analisis dokumentasi inventaris aset, laporan pemeliharaan, dan catatan anggaran. Partisipan dipilih secara purposif untuk memastikan representasi yang komprehensif. Temuan menunjukkan bahwa manajemen Sarpras memainkan peran penting dalam lima aspek utama: perencanaan kebutuhan, pengadaan, distribusi, pemeliharaan, dan pemanfaatan optimal fasilitas digital. Proses-proses ini berkontribusi secara signifikan dalam menciptakan lingkungan pembelajaran digital yang mendukung. Namun, efektivitasnya dibatasi oleh bandwidth internet yang tidak stabil dan anggaran yang terbatas untuk peningkatan peralatan yang sudah usang. Kesimpulannya, manajemen infrastruktur yang proaktif dan berkelanjutan sangat penting untuk memastikan pembelajaran digital berkualitas tinggi. Penguatan strategi pendanaan dan pembangunan kemitraan dengan penyedia layanan internet dan lembaga terkait direkomendasikan untuk meningkatkan kualitas infrastruktur digital.

Kata kunci: *Manajemen Infrastruktur dan Fasilitas, Pembelajaran Digital, TIK Sekolah Dasar, Efektivitas Manajemen, Infrastruktur Pendidikan, SDN 1 Tanjung Lago.*

Abstract

The integration of Information and Communication Technology (ICT) is essential in 21st-century education to support effective digital learning. This study analyzes the strategic role and effectiveness of infrastructure and facilities (Sarpras) management at SDN 1 Tanjung Lago in supporting digital learning implementation, as well as identifying the challenges encountered. This research employed a descriptive qualitative approach. Data were collected through triangulated techniques, including in-depth interviews with the principal, vice principal for curriculum, Sarpras coordinator, and selected teachers; participant observation of digital facility usage; and documentation analysis of asset inventories, maintenance reports, and budget records. Participants were selected purposively to ensure comprehensive representation. The findings reveal that Sarpras management plays a crucial role in five main aspects: needs planning, procurement, distribution, maintenance, and optimal utilization of digital facilities. These processes contribute significantly to creating a supportive digital learning environment. However, effectiveness is constrained by unstable internet bandwidth and limited budget for upgrading outdated equipment. In conclusion, proactive and sustainable infrastructure management is fundamental to ensuring high-quality digital learning. Strengthening funding strategies and building partnerships with internet service providers and related institutions are recommended to enhance digital infrastructure quality.

Keywords: Infrastructure and Facilities Management, Digital Learning, Primary School ICT, Management Effectiveness, Educational Infrastructure, SDN 1 Tanjung Lago.

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1. INTRODUCTION

The 21st century has fundamentally reshaped the landscape of education, establishing the imperative for integrating Information and Communication Technology (ICT) into the teaching and learning process a shift universally recognized as digital learning. This transformation is not merely an option but a core competency requirement for preparing students for the globalized, technology-driven workforce. Within this context, the role of physical and digital infrastructure and facilities (Sarpras) transcends that of mere supporting resources; they become determinants of educational quality and efficacy. The successful transition to and sustenance of a robust digital learning environment hinge critically upon the strategic planning, provision, and meticulous management of these facilities, including hardware, software, network connectivity, and specialized learning spaces. The urgency of this topic is heightened in primary schools *(Sekolah Dasar Negeri/SDN)* located in regional or potentially resource-constrained settings, where the challenge of bridging the digital divide is most acute.

It is widely acknowledged across educational research that the presence of well-maintained and accessible ICT infrastructure positively correlates with improved pedagogical outcomes and enhanced student engagement (Khan et al., 2021; UNESCO, 2020). Digital learning, which includes blended learning models, utilizes learning management systems, and incorporates interactive digital content, requires a base level of operational Sarpras specifically, reliable internet bandwidth, functional computer laboratories, modern digital devices (tablets, projectors), and the corresponding technical support (Yusuf & Ahmad, 2019). Furthermore, existing literature consistently establishes that the management process for these assets must encompass a cyclical approach involving planning, procurement, distribution, maintenance, and utilization to ensure their optimal lifespan and effectiveness (Suryadi & Tilaar, 2018). Effective Sarpras management is therefore understood as a strategic organizational function, not just a logistical task, essential for achieving national educational goals regarding technological literacy.

Despite the general consensus on the necessity of Sarpras management, a significant gap remains regarding the specific level of effectiveness and the nuanced strategic implementation of these management processes within individual primary schools in decentralized, non-urban areas of Indonesia. While macro-level data on national ICT readiness exists, the granular, micro-level operational challenges and successes unique to institutions like SDN 1 Tanjung Lago remain largely undocumented. Specifically, the field lacks in-depth qualitative analysis demonstrating how the five key management stages (planning based on digital curriculum analysis, context-appropriate procurement, equitable distribution, preventative maintenance regimes, and optimal teacher competency training for utilization) interact and ultimately influence the daily reality of digital pedagogy in this specific socio-economic context. Understanding the local constraints, particularly concerning budget limitations and fluctuating regional internet stability, requires focused investigation beyond general quantitative studies.

The current "state of the art" in educational technology research revolves around frameworks such as the TPACK (Technological Pedagogical Content Knowledge) model, which emphasizes that mere possession of technology is insufficient; teachers must integrate technology effectively with both content and pedagogy (Koehler & Mishra, 2009). The latest research also focuses on the Sustainability of Digital Resources, moving beyond initial

procurement to examine long-term operational costs, energy consumption, and the circular economy of educational hardware (Wang et al., 2022). Furthermore, the academic discourse has shifted towards Data-Driven Sarpras Planning, using student performance and usage data to justify and prioritize infrastructure investments, ensuring alignment with curriculum goals rather than simply responding to immediate needs (OECD, 2021). This study aligns with the State of the Art by utilizing a qualitative, case-study approach to explore how the *management function* can bridge the gap between technological availability (the 'C' in TPACK) and pedagogical integration (the 'P' and 'K' in TPACK) in a primary school setting.

The primary novelty of this research lies in its holistic and process-oriented analysis of digital Sarpras management within a single, representative Indonesian primary school (SDN 1 Tanjung Lago), framed through the lens of five specific management dimensions identified in the study's findings: Needs Planning, Procurement, Arrangement/Distribution, Scheduled Maintenance/Repair, and Optimal Utilization/Training. While previous studies may touch upon individual aspects, this research provides a comprehensive, sequential model detailing *how* these five management pillars collectively and strategically determine the success of digital transformation at the school level. The novelty is further enhanced by documenting the specific local challenges particularly the resource limitations and internet bandwidth stability issues and proposing context-specific solutions, thereby offering a valuable empirical case study for educational policymakers in similar non-urban regions.

The practical implication of this study is significant for school administrators, Sarpras coordinators, and educational policymakers. First, it contributes an evidence-based framework for school-level Sarpras management, allowing other primary schools facing similar resource constraints to benchmark and improve their operational efficiency. Second, the findings concerning the criticality of preventative maintenance and teacher technical training provide actionable recommendations for budget allocation priorities, moving funds from reactive repairs to proactive sustainability measures. Third, the study contributes to the academic field of educational administration by providing a detailed qualitative case study that validates the cyclical model of Sarpras management as a strategic driver of pedagogical change in the context of Indonesian primary education.

Various studies have shown that facility and infrastructure management plays a strategic role in improving the quality of learning. A study conducted by Kurniawan et al. (2025), through a systematic literature review of 20 scientific articles from 2020–2025, found that the quality of school facilities and infrastructure is positively correlated with the quality of learning. Professionally managed infrastructure integrated with digital technology has been shown to facilitate a more effective and efficient learning process. This finding aligns with research by Jannah et al. (2025), which emphasizes the importance of innovation in facility management to support digital learning, such as the implementation of a digital-based inventory system, the development of smart classrooms, and the use of interactive learning media. However, this study also identified major obstacles in the form of limited budget and human resource readiness.

Furthermore, qualitative research conducted by Chusna et al. (2026) shows that systematic facility management including planning, maintenance, and evaluation contributes significantly to creating a conducive learning environment and improving the quality of education. This is reinforced by a case study by Handayani and Hidayat (2025), which found that the effective implementation of POAC (Planning, Organizing, Actuating, Controlling)

management functions in school facility management can support improvements in the quality of student learning. Meanwhile, a program evaluation conducted by Arifin (2025) showed that procedurally and student-centered facility management facilitated a smooth learning process, although bureaucratic obstacles persisted in its implementation.

Another study by Amalia et al. (2024) revealed that strategic planning in facility and infrastructure management resulted in a more optimal learning environment, despite the challenges of budget constraints and technical constraints. In the context of technology-based innovation, Nuraini et al. (2025) found that technology integration in elementary school facility management can improve administrative efficiency, strengthen student learning interactions, and simplify the learning evaluation process. This is relevant to the findings of Yusutria et al. (2024), who emphasized the importance of maintaining and developing educational infrastructure in the 5.0 era to support more relevant, adaptive, and high-quality learning.

Furthermore, a literature review conducted by Elfina et al. (2022) confirmed that effective management of facilities and infrastructure contributes to a smooth learning process, increased effectiveness, and the provision of quality educational services. From a policy perspective, Jannah (2025) highlighted the importance of implementing national standards for educational facilities as stipulated in Government Regulation No. 57 of 2021 as part of a strategy to improve educational quality, including the provision of supporting infrastructure for digital learning, such as internet networks and technology-based learning spaces.

2. METHOD

This study employed a descriptive qualitative research approach (Creswell, 2014). This methodology was selected to facilitate an in-depth, holistic exploration of the complex, context-dependent phenomenon of infrastructure management effectiveness within a real-world educational setting. The descriptive nature of the research ensures that the strategic roles and challenges of the Sarpras management process are systematically documented and analyzed from the perspective of the actors involved, providing rich, contextual detail that quantitative methods cannot capture.

2.1 Type and Approach of the Study

The research was conducted at SDN 1 Tanjung Lago, located in the Tanjung Lago District, which serves as a representative case study of a primary school implementing digital learning initiatives in a non-urban area with typical resource constraints. Data collection activities, including interviews, observation, and documentation review, were performed over a period of three months, spanning from January to March 2024, ensuring comprehensive data saturation across various operational cycles of the school.

2.2 Location and Participants

The selection of research subjects utilized purposive sampling to ensure comprehensive representation from key stakeholders responsible for the planning, execution, and utilization of digital Sarpras. The chosen respondents included:

1. School Principal: As the primary decision-maker and policy setter.
2. Vice Principal for Curriculum: To provide insight into the pedagogical integration and curriculum alignment with Sarpras availability.
3. Infrastructure and Facilities Coordinator: As the central figure in the management process (planning, maintenance, and distribution).
4. Core Teachers: Teachers who actively utilize ICT and digital tools in their daily teaching practice, providing the user perspective on effectiveness and accessibility.

2.3 Research Design and Procedures

Data triangulation was rigorously applied to ensure the validity and reliability of the findings, utilizing the following three primary instruments:

1) In-Depth Interviews: Semi-structured interviews were conducted with all selected subjects. The interview guide focused on:
   a) The current digital learning policy
   b) The specific process and criteria for Sarpras Needs Planning and Procurement;
   c) Challenges related to maintenance, budget, and internet access; and
   d) Perceptions of the effectiveness of digital facility utilization in supporting learning outcomes.
2) Participant Observation: The researcher conducted observations focused on the *functional utilization* of digital facilities. This included: a) Monitoring the use of the computer laboratory during class hours; b) Assessing the physical condition, organization, and accessibility of digital devices (projectors, tablets) in classrooms; and c) Directly monitoring the real-time stability and speed of the school's Wi-Fi network (bandwidth quality) during peak usage times.
3) Documentation Study: The following official school documents were analyzed to provide objective evidence: a) Digital asset inventory data (age and condition of devices); b) Routine maintenance and repair logs; c) Sarpras budget allocation reports (APBS/BOS usage records); and d) Internal memos or policy guidelines related to the use of digital learning resources.

2.4 Data Collection Techniques

The collected qualitative data was analyzed using a systematic framework based on the thematic analysis approach, adapted from Miles and Huberman's (1994) interactive model. The steps involved were:

1. Data Reduction: Selecting, focusing, and simplifying the raw data (interview transcripts, observation notes, and documents) to identify recurring themes and core concepts related to the five management areas.
2. Data Display: Organizing the reduced data into visual matrices and descriptive narratives to allow for systematic comparison and pattern identification across different sources (e.g., comparing Coordinator's report vs. Teacher's experience).

3. Conclusion Drawing/Verification: Developing initial conclusions based on the displayed data, then verifying these conclusions by referring back to the original field notes and

triangulation across the three data sources (interview, observation, document) to ensure validity. This process aimed to generate thematic categories that directly answer the research question.

3. RESULT AND DISCUSSION

Result

The research findings confirm that the Sarpras management at SDN 1 Tanjung Lago fulfills a critical and multifaceted role in digital learning, which can be systematically categorized into five interdependent key areas of operation.

1. Needs Planning

The planning process is centralized and based on two primary inputs: the annual national curriculum directive (Kurikulum Digital) and a Gap Analysis comparing the school's existing assets against minimum digital competency standards. Interviews revealed that planning is *proactive*, with a three-year replacement cycle outlined for key assets, yet remains constrained by reliance on non-routine Bantuan Operasional Sekolah (BOS) funds.

2. Procurement

Procurement focuses on aligning hardware and software specifications with minimal standards for current digital content (e.g., procurement of tablets that can run the latest educational applications). The key finding here is the school's strategy of prioritizing network enhancement (Wi-Fi access points and routers) over device quantity, recognizing that connectivity is the primary bottleneck in the local context.

3. Arrangement and Distribution

Digital facilities are distributed according to an equitable access model. The Computer Laboratory serves as the centralized hub, but portable assets (projectors, charging carts for tablets) are systematically deployed to ensure all classrooms, regardless of grade level, have scheduled access. This is documented in the utilization schedule observed by the researcher.

4. Scheduled Maintenance and Repair

The school implements a structured, two-pronged maintenance regime: Preventive Maintenance (weekly cleaning, software updates, and basic network health checks performed by the Coordinator/designated technical teacher) and Corrective Maintenance (external vendor contracts for major hardware failures). However, budget constraints frequently lead to an extended delay in replacing devices deemed obsolete but not yet fully broken.

5. Optimal Utilization

The study found that optimal utilization is driven primarily by technical competency training for teachers. The Sarpras Coordinator holds mandatory bi-monthly workshops focusing not just on using the hardware but on integrating specific digital applications (e.g., Kahoot, Google Classroom) into lesson plans. This high level of focused training drives the successful adoption of the procured Sarpras.

Discussion

The findings of this study indicate that the management of educational facilities and infrastructure (sarana dan prasarana pendidikan) at SDN 1 Tanjung Lago demonstrates a relatively mature and strategic administrative approach. One of the most significant findings lies in the planning phase, where the school bases its needs planning on digital curriculum analysis and a gap analysis of existing resources. This approach represents a shift from traditional reactive asset replacement toward curriculum-driven infrastructure planning. Strategic alignment between educational infrastructure and pedagogical objectives is widely recognized as a critical factor in improving the effectiveness of technology integration in schools. When infrastructure investments are disconnected from instructional goals, resources often become underutilized or quickly obsolete (Tilaar & Amien, 2021).

The use of gap analysis in planning enables schools to systematically identify discrepancies between existing infrastructure conditions and the technological requirements needed to support digital learning activities. Through this process, administrators can prioritize procurement decisions based on pedagogical relevance rather than purely technical considerations. Similar findings were reported in studies on strategic educational planning, which emphasize that data-driven planning improves the efficiency of resource allocation and enhances institutional readiness for digital transformation (Dexter, 2020; Tondeur et al., 2021). In addition, effective infrastructure planning also helps schools avoid unnecessary expenditures by focusing on high-impact investments that directly support teaching and learning processes.

Another important aspect of the planning strategy at SDN 1 Tanjung Lago is the attempt to establish a three-year replacement cycle for digital devices. Although the implementation of this cycle is occasionally constrained by funding instability, the policy reflects good practice in asset life-cycle management. Research on educational infrastructure management highlights that systematic replacement planning helps maintain technological relevance while preventing sudden spikes in maintenance costs (Caldwell, 2019). Furthermore, efficient planning can significantly reduce waste in school infrastructure budgets. Studies on educational investment efficiency indicate that accurate needs assessment and long-term planning can reduce unnecessary spending by up to 20% of annual infrastructure expenditures (World Bank, 2022). This finding suggests that strategic planning is not only a managerial necessity but also an economic strategy for sustainable school development.

The procurement strategy observed in SDN 1 Tanjung Lago also reveals a sophisticated understanding of local technological constraints. Rather than prioritizing the acquisition of additional digital devices, the school chose to prioritize improvements in network infrastructure. This decision reflects a recognition that stable internet connectivity is a fundamental prerequisite for effective digital learning. Several studies emphasize that reliable network infrastructure is the backbone of modern technology-supported learning environments, particularly when educational activities rely on cloud-based platforms and online resources (Bond et al., 2021; Zhang & Aikman, 2022). Without stable connectivity, the availability of digital devices alone cannot guarantee meaningful technology integration in classrooms.

This finding contrasts with cases documented in earlier research where schools prioritized the procurement of individual student devices without addressing network limitations. In such situations, a significant proportion of digital devices remained underutilized due to poor

connectivity. The experience of SDN 1 Tanjung Lago therefore illustrates the importance of contextual decision-making in infrastructure procurement, where administrators must carefully evaluate the most critical technological bottlenecks before allocating resources.

Another notable aspect of the school's infrastructure management is the implementation of an equitable access model through portable charging carts and scheduled computer laboratory usage. This strategy aims to ensure that all students have equal opportunities to access digital resources regardless of classroom location or grade level. Educational equity in digital infrastructure is a growing concern in contemporary educational policy, particularly as digital learning environments expand across different regions and socio-economic contexts. Research on digital equity in education emphasizes that equitable distribution of technological resources is essential to prevent the emergence of a digital divide within schools (Zhang & Aikman, 2022).

Furthermore, studies on facilities accessibility indicate that well-organized infrastructure distribution can significantly improve learning efficiency by reducing transition time between activities and increasing students' effective engagement with digital tools (Darling-Hammond et al., 2020). In this regard, the approach adopted by SDN 1 Tanjung Lago demonstrates how infrastructure management can actively contribute to creating a more inclusive learning environment.

The maintenance phase of infrastructure management also plays a crucial role in ensuring the sustainability of digital facilities. The school has implemented a preventive maintenance regime that includes routine software updates, system monitoring, and physical equipment checks. Preventive maintenance is widely recognized as a critical factor in maintaining the functionality and longevity of educational technology. Research on total quality management in education emphasizes that proactive maintenance strategies can significantly extend the lifespan of technological assets and reduce operational disruptions (Fullan & Quinn, 2020).

However, this study also reveals challenges related to the replacement of obsolete devices. Due to budget limitations, some outdated but still functional devices remain in use even though they no longer support the latest educational software. Similar challenges have been reported in other studies, which indicate that operational budgets in schools often prioritize immediate expenditures such as salaries and utilities rather than long-term capital renewal (Caldwell, 2019). As a result, schools may accumulate what is sometimes referred to as a "ghost inventory," where technological assets technically exist but are no longer suitable for contemporary digital learning environments.

Despite these constraints, the effectiveness of infrastructure management at SDN 1 Tanjung Lago is particularly evident in the utilization phase, especially through the implementation of regular teacher training programs. The study found that the school conducts bi-monthly workshops focused on the practical application of digital tools in teaching and learning activities. This initiative highlights the importance of linking infrastructure management with human resource development. Technology itself does not automatically improve educational outcomes; its effectiveness depends largely on teachers' ability to integrate it into pedagogical practices.

This perspective aligns with research on technological pedagogical content knowledge (TPACK), which emphasizes that effective technology integration requires teachers to develop both technological competence and pedagogical strategies for digital instruction (Cabero-Almenara et al., 2020). Moreover, studies on teacher professional development

indicate that continuous training programs significantly increase teacher confidence and competence in using educational technologies (Garzón et al., 2020).

Previous research also demonstrates that teacher confidence is one of the strongest predictors of successful technology integration in classrooms. When teachers feel competent and supported in using digital tools, they are more likely to experiment with innovative teaching strategies and adopt technology-enhanced learning methods (Scherer et al., 2019). Conversely, studies have shown that schools with advanced technological infrastructure may still experience low utilization rates when teacher training focuses only on basic technical skills rather than pedagogical application.

Overall, the findings of this study suggest that the management of educational facilities and infrastructure at SDN 1 Tanjung Lago is characterized by a proactive and integrated approach across the key management stages of planning, procurement, utilization, and maintenance. The alignment between infrastructure planning and curriculum needs, the prioritization of network reliability, the implementation of equitable access strategies, and the emphasis on teacher training collectively contribute to the effective utilization of digital resources in the school.

Nevertheless, the sustainability of these efforts remains influenced by external factors, particularly fluctuations in internet bandwidth stability and limitations in infrastructure renewal budgets. Addressing these challenges requires not only internal management improvements but also broader institutional support, including policy alignment, funding strategies, and community partnerships. In this context, effective leadership and collaborative governance are essential for ensuring the long-term sustainability of digital infrastructure in schools.

4. CONCLUSION

This study concludes that the management of educational facilities and infrastructure at SDN 1 Tanjung Lago has been implemented effectively through strategic planning, procurement, utilization, and maintenance aligned with digital learning needs. The planning process based on curriculum analysis and gap analysis enables the school to prioritize infrastructure that directly supports teaching and learning activities. The procurement strategy that emphasizes network infrastructure, equitable access to digital facilities, and preventive maintenance practices contributes to the sustainability and effectiveness of technology use in the school. In addition, regular teacher training plays an important role in ensuring that digital facilities are utilized optimally in classroom instruction.

The findings imply that effective infrastructure management requires alignment between technological investment, pedagogical objectives, and teacher professional development. Schools and policymakers should therefore prioritize curriculum-based planning, strengthen internet infrastructure, and provide continuous training to support technology integration. However, challenges such as unstable internet connectivity and limited funding for equipment renewal remain important issues that require institutional support and policy intervention. Future research is recommended to examine digital infrastructure management across multiple schools and to explore its long-term impact on student learning outcomes, motivation, and digital competence.

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