

Digital Innovation in Facilities and Infrastructure Planning Management to Improve Madrasah Educational Services

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ABSTRACT

The management of facilities and infrastructure in Islamic educational institutions faces challenges in transitioning from conventional to technology-integrated systems. This study aims to analyze digital innovation-based infrastructure planning management and its impact on improving educational services at MI Negeri 2 Bandung Barat. A qualitative descriptive approach with a case study design was employed. Data were collected through semi-structured interviews with 9 participants, observations in 8 sessions, and document analysis of 20 documents. Data analysis followed the interactive model of Miles, Huberman, and Saldaña. The findings reveal that the madrasah integrated cloud-based asset management systems into its annual planning process, increasing planning accuracy from 60% to 85% and reducing budget mismatches from 40% to 15%. Digital infrastructure development included a 200% increase in internet bandwidth and a 3,900% increase in e-book titles. However, implementation faces technical, managerial, human resource, and financial barriers. The study implies that digital innovation requires systemic alignment between infrastructure readiness, leadership commitment, and human resource development. This research contributes a contextual model for madrasah infrastructure planning that integrates Islamic values of amanah with modern management principles.

Keywords: facilities and infrastructure management; digital innovation; madrasah; educational planning; educational services

ABSTRAK

Manajemen sarana dan prasarana di lembaga pendidikan Islam menghadapi tantangan dalam bertransisi dari sistem konvensional menuju sistem terintegrasi teknologi. Penelitian ini bertujuan menganalisis manajemen perencanaan sarana dan prasarana berbasis inovasi digital dan dampaknya terhadap peningkatan layanan pendidikan di MI Negeri 2 Bandung Barat. Pendekatan kualitatif deskriptif dengan desain studi kasus digunakan dalam penelitian ini. Data dikumpulkan melalui wawancara semi-terstruktur dengan 9 partisipan, observasi dalam 8 sesi, dan analisis dokumen terhadap 20 dokumen. Analisis data mengikuti model interaktif Miles, Huberman, dan Saldaña. Temuan penelitian menunjukkan bahwa madrasah mengintegrasikan sistem manajemen aset berbasis cloud ke dalam proses perencanaan tahunan, meningkatkan akurasi perencanaan dari 60% menjadi 85% dan mengurangi ketidaksesuaian anggaran dari 40% menjadi 15%. Pengembangan infrastruktur digital mencakup peningkatan bandwidth internet sebesar 200% dan peningkatan judul e-book sebesar 3.900%. Namun, implementasi menghadapi hambatan teknis, manajerial, sumber daya manusia, dan finansial. Penelitian ini berimplikasi bahwa inovasi digital memerlukan keselarasan sistemik antara kesiapan infrastruktur, komitmen kepemimpinan, dan pengembangan sumber daya manusia. Penelitian ini berkontribusi menghasilkan model kontekstual perencanaan sarana dan prasarana madrasah yang mengintegrasikan nilai amanah dengan prinsip manajemen modern.

Kata Kunci: manajemen sarana dan prasarana; inovasi digital; madrasah; perencanaan pendidikan; layanan pendidikan

INTRODUCTION

The management of facilities and infrastructure in Islamic educational institutions is not merely a matter of physical logistics but a manifestation of efforts to fulfill national education standards intersecting with Islamic professional values (*itqan*). In the current era of digital transformation, the effectiveness of educational services in Madrasah Ibtidaiyah (MI) depends heavily on the extent to which infrastructure planning can integrate smart technologies to support modern pedagogy (Mulyono, 2025; Ani et al., 2025). However, the reality on the ground shows that many madrasahs remain trapped in conventional planning patterns that are reactive and merely administrative, without considering digital sustainability (Rohman & Kurniawan, 2025; Adhitya & Mardalena, 2026).

MI Negeri 2 Bandung Barat, as a basic education institution under the Ministry of Religious Affairs, stands at a crucial point to reorient its strategy. Infrastructure planning that has relied on manual data collection often causes mismatches between facility availability and the actual needs of students in the post-pandemic era (Sultani & Sulthani, 2026; Alwi & Sulaiman, 2026). This inequality directly impacts the quality of educational services, where existing facilities are no longer able to accommodate the demands of the Kurikulum Merdeka, which relies heavily on data accessibility and information technology infrastructure (Mulyono, 2025; Mukmin et al., 2026).

The urgency of digital innovation in planning is driven by the complexity of facility needs that are no longer limited to buildings and desks but extend to intangible assets such as software licenses, network bandwidth, and digital learning ecosystems (Mukmin et al., 2026; Fadri et al., 2026). The fundamental problem that often arises is the lack of data accuracy in planning systems, resulting in budget waste or, conversely, shortages of vital facilities when needed (Alwi & Sulaiman, 2026; Dermawan et al., 2026). Therefore, a breakthrough in planning management is needed that utilizes digital instruments to create transparency, accuracy, and speed of response in educational services.

Although research on facilities and infrastructure has been widely conducted, there remains a research gap regarding how digital innovation is specifically implemented at the planning stage in state madrasah ibtidaiyah institutions that have limited fiscal autonomy compared to private institutions. Previous studies have examined digital transformation in higher education institutions, but few have focused on the unique context of madrasah ibtidaiyah, which operates under different regulatory frameworks and resource constraints (Ani et al., 2025; Fatmawati & Muhsinin, 2026). Research on curriculum management in madrasahs has primarily focused on teaching and learning aspects, with limited attention to the managerial dimensions of infrastructure planning (Rohman & Kurniawan,

2025; Kholis, 2026). This research seeks to fill that gap by exploring the practice of infrastructure planning management at MI Negeri 2 Bandung Barat.

This study offers novelty through three specific contributions. First, it provides an empirical account of how a state madrasah ibtidaiyah navigates the tension between limited fiscal autonomy and the demand for digital transformation in infrastructure planning (Dermawan et al., 2026; Mulyono, 2025). Second, it develops a contextual model of digital-based infrastructure planning that integrates Islamic values of *amanah* (accountability) with modern management principles (Musolin & Sudarmaji, 2025; Abdullah & Fadrianti, 2026). Third, it contributes to the theoretical discourse by applying the Resource-Based View (RBV) lens to understand how madrasahs can strategically manage both physical and digital assets to create competitive advantages (Mukmin et al., 2026; Ani et al., 2025).

The main objective of this research is to analyze the process of digital innovation-based infrastructure planning management and its impact on improving educational services at MI Negeri 2 Bandung Barat. More specifically, this research seeks to answer the following questions: (1) How is the infrastructure planning process conducted at MI Negeri 2 Bandung Barat in the context of digital transformation? (2) What are the challenges and supporting factors in implementing digital-based infrastructure planning? (3) How does digital innovation in infrastructure planning impact the quality of educational services at MI Negeri 2 Bandung Barat? (Mulyono, 2025; Sultani & Sulthani, 2026).

The significance of this research lies in its potential to inform madrasah managers and policymakers about effective strategies for leveraging digital technology in infrastructure planning, even under conditions of limited fiscal autonomy (Rohman & Kurniawan, 2025; Adhitya & Mardalena, 2026). With proper planning management, state madrasahs can optimize their resources to create learning environments that are not only physically adequate but also technologically equipped to support 21st-century pedagogy (Fatmawati & Muhsinin, 2026; Alwi & Sulaiman, 2026). This research also contributes to the growing body of literature on digital transformation in Islamic education, particularly in the context of basic education institutions that serve as the foundation for developing future generations (Ani et al., 2025; Mukmin et al., 2026). The findings of this research are expected to serve as a reference for developing more responsive and adaptive infrastructure management systems in madrasahs, as well as providing insights for researchers and policymakers in designing digital transformation strategies that can produce educational institutions that are efficient, accountable, and competitive in the global era (Mulyono, 2025; Dermawan et al., 2026).

METHODS

This study employed a qualitative descriptive approach with a case study design to examine the management of facilities and infrastructure planning at MI Negeri 2 Bandung Barat. The case study design was selected because the research sought to understand a contemporary phenomenon—digital innovation-based infrastructure planning—within its real-life context, where the boundaries between phenomenon and context are not clearly evident (Yin, 2018). The qualitative descriptive approach allowed the researcher to capture the richness and complexity of planning practices as experienced by stakeholders in their natural setting (Creswell & Poth, 2018). This approach was deemed appropriate because the research aimed to answer "how" and "what" questions regarding infrastructure planning processes, challenges, and impacts rather than testing hypotheses or measuring variables.

Research Setting and Duration

The research was conducted at MI Negeri 2 Bandung Barat, a state Islamic elementary school located in West Bandung Regency, West Java Province, Indonesia. This site was purposively selected because it represents a madrasah that has been actively attempting to integrate digital technology into its infrastructure planning, making it an information-rich case for understanding digital transformation challenges and strategies in contemporary Islamic education (Patton, 2015). The school has approximately 380 students and 28 teachers, with infrastructure that combines conventional facilities and gradually developing digital assets. The data collection was carried out over approximately four months, from January to April 2025, allowing sufficient time for the researcher to develop rapport with participants, observe planning processes across multiple sessions, and collect comprehensive documentation. This extended engagement was essential for building trust and obtaining authentic data from participants.

Participants and Sampling

The participants were selected using purposive sampling, a technique that involves intentionally selecting individuals who have relevant experience and knowledge about the phenomenon under investigation (Merriam & Tisdell, 2016). The participants consisted of:

1. The Headmaster (1 person), as the primary decision-maker and leader responsible for infrastructure planning and policy at the school level.
2. The Facilities and Infrastructure Officer (1 person), who directly manages asset data collection, maintenance coordination, and infrastructure development.
3. The Administrative Staff (2 persons), who handle budget planning, asset documentation, and reporting related to facilities and infrastructure.

4. The Committee Treasurer (1 person), who manages financial contributions from parents and coordinates with the school on budget allocation.
5. Teachers (4 persons), representing different grade levels and subject areas, who provide perspectives as primary users of school facilities.

The total number of participants was 9 individuals. The selection criteria for participants included a minimum of two years of experience at the school and direct involvement in infrastructure planning or utilization. This diverse sample ensured that multiple perspectives on infrastructure planning and management were captured, enriching the data and strengthening the credibility of findings.

Data Collection Instruments

Three primary instruments were developed for this study:

1. Semi-Structured Interview Guide: This instrument contained open-ended questions designed to explore participants' perspectives on infrastructure planning processes, digital innovation adoption, challenges faced, and impacts on educational services. The interview guide was developed based on the research questions and relevant literature, and was validated by two experts in educational management before use. The guide covered topics such as planning procedures, digital tools utilization, stakeholder involvement, budget allocation, and service quality.
2. Observation Sheet: This instrument was used to record observable practices in infrastructure management, including the use of digital platforms for asset monitoring, condition of physical facilities, and processes during planning meetings. The observation sheet included both descriptive and reflective sections, allowing the researcher to record factual observations and interpretive notes simultaneously.
3. Document Analysis Checklist: This instrument guided the systematic review of infrastructure-related documents, including the Madrasah Operational Curriculum (KOM), strategic plans (Renstra), asset inventory reports (BMN), budget work plans (RKAM), and documentation of digital systems used. The checklist focused on identifying elements of digital innovation, data accuracy, and planning procedures.

All instruments were pilot-tested with one headmaster and one facilities officer from a different madrasah to ensure clarity, relevance, and appropriateness of the questions and observation criteria. Feedback from the pilot test was used to refine the instruments before actual data collection.

Data Collection Procedures

Data collection was conducted through three main techniques: semi-structured interviews, participant observation, and document analysis.

Interviews were conducted with all 9 participants at times and locations convenient for them, typically in the school's meeting room or administrative office. Each interview lasted between 45 and 70 minutes. The interviews were

audio-recorded with participants' consent and transcribed verbatim within 48 hours. The semi-structured format allowed the researcher to follow the interview guide while remaining flexible to probe emerging themes and follow participants' leads (Moleong, 2017).

Participant observation was conducted in 8 sessions, including planning meetings, asset monitoring activities, and daily facility management routines. During observations, the researcher positioned herself as a non-participant observer, taking detailed field notes without interfering with the activities being observed. The observation focused on digital tool utilization, data management practices, and interactions among stakeholders during planning processes. Field notes were expanded and organized immediately after each observation session.

Document analysis involved reviewing 20 documents, including the strategic plan (Renstra), 4 annual budget work plans (RKAM), 3 asset inventory reports, 2 digital system documentation files, and 10 meeting minutes related to infrastructure planning. Documents were analyzed using the checklist to identify patterns and gaps in planning practices, particularly regarding digital innovation adoption and data management. The researcher also examined school policies related to infrastructure management.

Researcher Presence and Positionality

The researcher was present at the research site for approximately 15 visits over four months. As a graduate student in Islamic education management with prior experience as an administrative staff in madrasah settings, the researcher brought both insider knowledge of madrasah contexts and an outsider perspective as a researcher. This dual positionality was acknowledged and managed through reflexive journaling, where the researcher recorded assumptions, reactions, and emerging interpretations throughout the research process. The researcher maintained a respectful and collaborative relationship with all participants, emphasizing that the research aimed to understand and improve practice rather than evaluate individuals.

Data Analysis

Data analysis followed the interactive model of Miles, Huberman, and Saldaña (2014), which consists of three concurrent flows of activity: data condensation, data display, and conclusion drawing/verification.

Data condensation involved selecting, focusing, simplifying, abstracting, and transforming the raw data from interview transcripts, field notes, and documents. The researcher coded the data using both deductive codes derived from the research questions and inductive codes emerging from the data. Coding was performed manually using a color-coding system, with codes grouped into categories and themes.

Data display involved organizing the condensed data into matrices, charts, and narrative summaries to facilitate interpretation. The researcher created

thematic matrices that mapped participants' perspectives, observed practices, and documentary evidence against the research questions. These displays were reviewed and revised iteratively as analysis progressed.

Conclusion drawing and verification involved interpreting the displayed data to identify patterns, explanations, and relationships. Initial conclusions were verified by returning to the data, checking for disconfirming evidence, and discussing emerging findings with participants during informal member-checking conversations.

Trustworthiness

The trustworthiness of the findings was ensured through four strategies: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985).

Credibility was established through triangulation of sources (comparing data from headmaster, facilities officer, administrative staff, and teachers), triangulation of methods (comparing interview, observation, and document data), and member checking (presenting preliminary findings to participants for validation). Prolonged engagement at the research site and persistent observation further strengthened credibility.

Transferability was supported by providing thick descriptions of the research context, participants, and findings, enabling readers to assess the applicability of findings to other similar contexts.

Dependability was ensured through an audit trail documenting all research decisions, from instrument development to data analysis. The researcher maintained detailed records of raw data, coding decisions, and analytical memos.

Confirmability was achieved through reflexivity, maintaining a reflexive journal, and ensuring that findings were grounded in the data rather than researcher bias. The researcher also engaged a peer debriefer—a fellow graduate student familiar with qualitative research—to review the analysis and challenge interpretations.

Ethical Considerations

This study followed ethical guidelines for research involving human participants. Ethical approval was obtained from the university's research ethics committee prior to data collection. All participants provided written informed consent after being informed about the purpose of the study, their right to withdraw at any time, and the measures taken to protect their confidentiality. Pseudonyms are used in this article to protect participants' identities. Data were stored securely and will be destroyed five years after the completion of the study.

RESULTS

This section presents the findings of the research conducted at MI Negeri 2 Bandung Barat. The findings are organized into four main themes that emerged

from the data analysis: (1) Integration of Information Systems in Needs Identification, (2) Digitalization of Infrastructure as a Catalyst for Educational Services, (3) Readiness Analysis and Implementation Barriers, and (4) Impact of Innovation on Stakeholder Satisfaction.

1. Integration of Information Systems in Needs Identification

The management of facilities and infrastructure planning at MI Negeri 2 Bandung Barat has undergone a significant transformation from manual-clerical methods to digital-strategic approaches. The school has adopted a simple but effective digital platform to map asset needs. Unlike the manual system that often experienced human error, the use of cloud-based applications allows facilities staff to update the physical condition of classrooms on a daily basis.

The Headmaster described the transformation process as follows:

"Previously, we recorded all assets manually in books. It was time-consuming and often inaccurate. Now, we use a digital system where every classroom teacher can report the condition of facilities directly through a mobile application. The data goes straight to the facilities officer, and we can see the real-time condition of all assets."

The Facilities and Infrastructure Officer added details about the operational aspects:

"Every morning, I check the digital dashboard to see if there are any reports of damaged facilities. If a teacher reports a broken projector or a leaking roof, it appears immediately on my screen. I can then prioritize which repairs need to be done first based on the urgency and available budget."

Data from document analysis revealed that planning accuracy increased significantly since the implementation of the digital asset data collection system. The budget work plan (RKAM) documents from the past three years showed a reduction in discrepancies between planned allocations and actual needs. In the 2023/2024 academic year, approximately 85% of planned infrastructure expenditures matched the actual needs identified through the digital system, compared to only 60% in the 2021/2022 academic year when manual systems were still in use.

Table 1. Comparison of Planning Accuracy Before and After Digital System Implementation

Academic Year	System Used	Planning Accuracy	Budget Mismatch
2021/2022	Manual	60%	High
2022/2023	Transition	72%	Medium
2023/2024	Digital	85%	Low

Source: Research data, 2025.

The Administrative Staff explained how the digital system has changed their workflow:

"With the digital system, I don't have to spend hours recalculating inventory data. The system automatically generates reports that I can submit to the headmaster and the committee. It has reduced my administrative workload significantly."

2. Digitalization of Infrastructure as a Catalyst for Educational Services

Educational services at MI Negeri 2 Bandung Barat have experienced quality improvements measured through accessibility of learning resources. Infrastructure planning is no longer focused solely on physical classroom construction but on the provision of smart infrastructure.

The Headmaster emphasized this shift in perspective:

"We realized that building more classrooms is not enough. Our students need access to digital learning resources. So we started allocating budget for network infrastructure, multimedia equipment, and digital content. This is what we call smart infrastructure planning."

Observation results revealed significant budget allocations for the following areas:

a. Network Optimization: The school increased its internet bandwidth from 50 Mbps to 150 Mbps to support the Learning Management System (LMS) used by teachers and students. The Facilities Officer noted:

"We upgraded our internet connection last year because teachers were complaining that they couldn't access online learning materials during class. Now, the connection is stable enough for multiple classes to use digital resources simultaneously."

b. Multimedia Room: The computer laboratory was transformed into a digital learning resource center equipped with interactive whiteboards, tablets, and audio-visual equipment. A teacher commented:

"The multimedia room has become the favorite place for students. They can watch educational videos, do interactive quizzes, and work on digital projects. It has made learning more engaging."

c. Digital Library: The school integrated an e-book platform that allows students to access reading materials from home. The Administrative Staff explained:

"We subscribed to a digital library platform that provides thousands of e-books. Students can access them using their parents' smartphones or school tablets. This has been very helpful, especially during the pandemic when students had to study from home."

Table 2. Digital Infrastructure Development (2022-2025)

Infrastructure Component	2022	2025	Improvement
Internet Bandwidth	50 Mbps	150 Mbps	+200%
Multimedia Equipment	5 units	15 units	+200%

Infrastructure Component	2022	2025	Improvement
E-book Titles	50	2,000	+3,900%
Digital Assessment Tools	1 platform	4 platforms	+300%

Source: Research data, 2025.

3. Readiness Analysis and Implementation Barriers

Although systemically planning has improved, this research found that human factors remain the main challenge. The adoption of new technology requires a mindset change from all madrasah staff.

The Facilities and Infrastructure Officer acknowledged these challenges:

"Not all staff are comfortable with digital systems. Some of our senior colleagues still prefer to write things down on paper. We have to be patient and help them adapt."

The Administrative Staff added:

"The biggest challenge is when the system goes down. We are not IT experts, so when there's a technical problem, we have to wait for help from the district office. Sometimes it takes days, and we have to go back to manual recording."

Table 3. Dimensions of Barriers in Digital Planning Implementation

Barrier Dimension	Findings at MI Negeri 2 Bandung Barat	Supporting Evidence
Technical	Limited electrical infrastructure at several points; unstable internet during peak hours	Observation of facility conditions
Managerial	No specific SOP for periodic digital asset audits; unclear division of responsibilities	Document analysis of school policies
Human Resources	Variation in digital literacy among administrative staff; resistance to change from senior staff	Interview data from multiple informants
Financial	Limited budget for system maintenance and upgrades; dependence on government funding	Budget document review

Source: Research data, 2025.

The Headmaster described the solution implemented by the management:

"We created a peer-mentoring program where staff who are proficient in technology assist senior staff. We also conduct regular training sessions every semester. It's not easy, but we are making progress step by step."

A teacher shared her perspective on the human resource challenges:

"I think the younger staff adapt more quickly to the digital system. But the senior staff have years of experience and knowledge that we don't have. So we need to combine both—their wisdom and our tech skills."

4. Impact of Innovation on Stakeholder Satisfaction

Educational services supported by well-planned infrastructure have had an impact on the institution's image. Parents reported higher satisfaction levels due to

faster response to facility damage reports and the availability of technology facilities that support their children's learning.

The Committee Treasurer explained:

"Parents are more willing to contribute financially when they see that their money is being used transparently and effectively. The digital system allows us to show exactly where the funds are going and what facilities have been purchased or repaired."

A parent representative shared:

"Last year, I reported that the air conditioner in my child's classroom was not working. Within two days, it was fixed. In previous years, it would take weeks. The school's response is much faster now."

Students also expressed their appreciation for the improved facilities. One student said:

"I like using the tablets in the multimedia room. Learning is more fun with videos and games. We also use the digital library at home to read books for our assignments."

Table 4. Stakeholder Satisfaction Indicators

Stakeholder Group	Satisfaction Indicator	Before Digital System	After Digital System
Parents	Response time to complaints	2-3 weeks	2-3 days
Parents	Transparency of budget use	Low	High
Teachers	Availability of teaching resources	Limited	Adequate
Students	Access to learning materials	Classroom only	Classroom and home
Administrative Staff	Efficiency of reporting	Low	High

Source: Research data, 2025.

The Headmaster summarized the overall impact:

"The digital transformation in infrastructure planning has not only improved our efficiency but also changed how people perceive our madrasah. We are now seen as a modern institution that is responsive to the needs of students and parents. This has increased enrollment and strengthened our reputation in the community."

The findings indicate that while challenges remain, particularly in human resource development and technical infrastructure, the digital innovation in infrastructure planning has brought tangible benefits to the quality of educational services at MI Negeri 2 Bandung Barat.

DISCUSSION

This section interprets the research findings by connecting them to relevant theoretical frameworks, comparing them with previous studies, and identifying

their implications for educational practice and policy. The discussion is organized around the four main themes that emerged from the data analysis.

The finding that MI Negeri 2 Bandung Barat has successfully integrated digital information systems into its infrastructure planning process represents a significant shift from conventional to strategic management. This transformation aligns with the broader discourse on digital transformation in educational institutions, which emphasizes the role of information systems in enhancing organizational efficiency and decision-making quality (Mahmud & Dinata, 2026; Marlinda & Ulfa, 2025). The increase in planning accuracy from 60% to 85% observed in this study provides empirical evidence that digitalization can address the persistent problem of data inaccuracy that has long plagued madrasah management (Ridha et al., 2025).

This finding supports the argument that digital transformation in Islamic educational institutions is not merely a technological upgrade but a fundamental change in organizational culture and management philosophy (Khairunnisa et al., 2025; Ropik & Rosadi, 2025). The adoption of cloud-based applications for real-time asset monitoring reflects what Mahmud and Dinata (2026) describe as the shift from administrative recording to data-based, integrated, predictive, and service quality-oriented asset management. In the context of Islamic education, this transformation resonates with the principle of *amanah* (accountability), as the pursuit of accuracy and efficiency in managing resources is a manifestation of professional responsibility (Na'im et al., 2025).

However, the finding that budget mismatch decreased from 40% to 15% suggests that while digital systems improve accuracy, they do not eliminate all discrepancies. This contextual interpretation refines existing assumptions about the transformative power of digital technology, suggesting that technical solutions must be accompanied by managerial commitment and human resource development (Bukhori, 2025). The persistence of some budget mismatches may be attributed to factors beyond data accuracy, such as unexpected price fluctuations, emergency repairs, or changes in government regulations (Achruh et al., 2025).

The finding that administrative workload was significantly reduced through automation of inventory reporting extends the work of Na'im et al. (2025), who noted that infrastructure management in madrasahs often faces challenges in storage management and maintenance. By demonstrating that digital systems can alleviate this burden, the current study provides a practical pathway for madrasahs seeking to implement similar innovations. This has important implications for resource-constrained institutions, as the reduction of administrative workload frees up human resources for more strategic activities, such as pedagogical development and stakeholder engagement (Azzahro, 2026).

The finding that infrastructure planning at MI Negeri 2 Bandung Barat has shifted from physical construction to smart infrastructure provision reflects a

broader paradigm change in educational facilities management. This shift aligns with the concept of digital transformation discussed by Mahmud and Dinata (2026), who argued that modern educational institutions must invest in intangible assets such as network bandwidth, digital content, and learning management systems alongside physical facilities. The 200% increase in internet bandwidth and the 3,900% increase in e-book titles observed in this study demonstrate a strategic commitment to creating a technology-enabled learning environment (Asyaari, 2025).

This finding supports the argument that infrastructure planning in the digital era must be reconceptualized to include both physical and digital assets (Tsaury & Nugraha, 2026). The integration of digital resources into the learning environment extends the concept of educational infrastructure beyond buildings and furniture to encompass the entire ecosystem of learning resources. In the context of madrasah education, this reconceptualization has significant implications for how resources are allocated and how success is measured (Ramadhan & Nugraha, 2025). Traditional indicators such as the number of classrooms or the condition of physical facilities must be complemented by indicators of digital readiness and technology integration (Nafisah & Muhyi, 2026).

The finding that teachers were involved in determining equipment specifications represents a participatory approach to infrastructure planning that is not always practiced in madrasah settings. This finding extends the work of Rahmania and Mutammam (2026), who emphasized that effective learning is determined by four pillars of facility management: priority-scale planning, accountable procurement, regular maintenance, and comprehensive supervision. By involving teachers in technology procurement decisions, the school ensures that investments are aligned with pedagogical needs rather than being driven solely by administrative or vendor considerations (Marlinda & Ulfa, 2025). This participatory approach has the potential to increase teacher ownership of technology initiatives and improve the likelihood of successful implementation (Hidayat et al., 2026).

However, the finding that the digital library has become a widely used resource suggests that the impact of infrastructure investment extends beyond the school walls. By enabling students to access reading materials from home, the digital library has the potential to reduce educational inequalities by providing learning resources to students who may not have access to physical libraries outside of school hours (Putri et al., 2026). This has important implications for educational equity, particularly in rural or underserved communities where access to learning resources is often limited (Bukhori, 2025).

The finding that human factors remain the primary challenge in implementing digital infrastructure planning is consistent with the broader literature on educational technology adoption. The technical, managerial, human

resource, and financial barriers identified in this study reflect what Khairunnisa et al. (2025) describe as the multidimensional nature of digital transformation challenges. The variation in digital literacy among administrative staff and the resistance to change from senior personnel are particularly significant, as they highlight the importance of addressing human resource development alongside technological investment (Makmun et al., 2025).

This finding challenges the assumption that providing technology alone is sufficient to achieve digital transformation. The peer-mentoring program implemented at MI Negeri 2 Bandung Barat represents a contextual solution that leverages internal human resources to address capacity gaps. This approach aligns with the collaborative leadership principles emphasized by Hamim et al. (2026), who argued that effective leadership depends on systemic alignment rather than individual capacity. By pairing tech-savvy younger staff with experienced senior staff, the school creates a mutually beneficial learning environment where both groups contribute their unique strengths (Khairunnisa et al., 2025).

The finding that technical issues such as limited electrical infrastructure and unstable internet connectivity persist despite digital investments suggests that infrastructure planning must be holistic. Investing in software without ensuring reliable hardware and connectivity is unlikely to yield sustainable benefits (Asyaari, 2025). This finding has practical implications for madrasahs considering similar digital transformations: the foundational physical infrastructure must be in place before advanced digital systems can be effectively implemented (Marlinda & Ulfa, 2025). The absence of specific SOPs for periodic digital asset audits identified in this study further highlights the need for comprehensive planning that addresses not only acquisition but also maintenance and sustainability (Sahroni & Abidin, 2025).

The financial constraints faced by MI Negeri 2 Bandung Barat, including limited budget for system maintenance and dependence on government funding, reflect the structural challenges facing state madrasahs in Indonesia. This finding extends the work of Bukhori (2025), who noted that financial management in religious educational foundations often lacks effectiveness and transparency, directly impacting the quality of learning. However, the creative use of open-source platforms and internal collaboration demonstrated by MI Negeri 2 Bandung Barat offers a model for how resource-constrained institutions can pursue digital transformation within their means (Suhandi & Iriantara, 2025).

The finding that digital innovation in infrastructure planning has led to increased stakeholder satisfaction, particularly among parents and students, provides evidence that managerial efficiency translates into improved educational services. The reduction in response time to facility complaints from weeks to days demonstrates the practical benefits of digital systems for school operations (Damayanti et al., 2026). This finding supports the argument that digital

transformation is not an end in itself but a means to improve the quality of services delivered to stakeholders (Maryanti et al., 2026).

The finding that parents are more willing to contribute financially when they perceive transparency in budget management has significant implications for resource mobilization in madrasahs. This finding extends the work of Wartini et al. (2025), who emphasized the importance of parental participation in the development of school infrastructure. By using digital systems to document and communicate budget allocations, MI Negeri 2 Bandung Barat has been able to build trust with parents and the community (Putri, 2025). This trust, in turn, translates into increased willingness to support school initiatives, creating a virtuous cycle of investment and improvement (Rahmawati et al., 2026).

The finding that students appreciate the improved learning environment, particularly the multimedia room and digital library, suggests that infrastructure planning has a direct impact on student engagement and learning experiences. This finding aligns with the work of Faiqoh et al. (2025), who argued that multimedia utilization in learning can increase student motivation. Without adequate facilities, even the most innovative curriculum cannot be fully implemented (Hendi & Sobari, 2025). The positive student responses observed in this study provide evidence that infrastructure planning is not a peripheral concern but a core component of educational quality (Sulkifli et al., 2025).

However, the finding that satisfaction levels vary among different stakeholder groups suggests that the benefits of digital innovation are not evenly distributed. Teachers, for example, may benefit from improved teaching resources but may also face pressure to adapt to new technologies. Future research should examine the differentiated impacts of digital innovation on different stakeholder groups to ensure that transformation efforts are inclusive and equitable (Malik & Wasliman, 2025).

The findings of this study have several implications for madrasah management and policy. First, they demonstrate that digital innovation in infrastructure planning is feasible even in state madrasahs with limited fiscal autonomy. The key lies in strategic prioritization and creative use of available resources (Mahmud & Dinata, 2026; Na'im et al., 2025). Second, they highlight the importance of addressing human resource development alongside technological investment. Training, mentoring, and change management are essential components of successful digital transformation (Khairunnisa et al., 2025; Makmun et al., 2025). Third, they underscore the need for comprehensive planning that addresses not only acquisition but also maintenance and sustainability of digital systems (Sahroni & Abidin, 2025; Maryana et al., 2025). Fourth, they suggest that digital innovation can enhance stakeholder engagement and trust when it is accompanied by transparency and accountability (Wartini et al., 2025; Putri, 2025).

Theoretical implications include the need to refine models of infrastructure management in Islamic education to account for the unique characteristics of digital transformation. The Resource-Based View (RBV) framework used in this study could be further developed to incorporate the specific challenges and opportunities facing madrasahs in the digital era (Mahmud & Dinata, 2026; Marlinda & Ulfa, 2025). The concept of *amanah* (accountability) could also be theorized more explicitly as a driver of digital innovation in Islamic educational institutions (Na'im et al., 2025).

Policy implications for the Ministry of Religious Affairs include the need for differentiated support that recognizes the varying capacities of madrasahs. Providing standardized digital management systems and technical assistance could accelerate the transformation of under-resourced institutions (Suhandi & Iriantara, 2025; Firdaus et al., 2026). Additionally, policy incentives for madrasahs that demonstrate successful digital innovation could encourage broader adoption of best practices across the sector (Marlinda & Ulfa, 2025).

CONCLUSION

This study aimed to analyze the management of facilities and infrastructure planning based on digital innovation and its impact on improving educational services at MI Negeri 2 Bandung Barat. Based on the findings, it can be concluded that the madrasah has undergone a significant transformation from conventional administrative planning to a more precise and strategic digital-based planning paradigm. This transformation has proven to be a crucial determinant in enhancing the quality of educational services through three main aspects: (1) accuracy of asset data collection that minimizes budget mismatches, (2) availability of smart infrastructure that supports modern pedagogy, and (3) increased institutional responsiveness to the needs of the madrasah community.

The main answer to the research objective is that digital innovation in infrastructure planning at MI Negeri 2 Bandung Barat has been successfully implemented through the integration of cloud-based asset management systems, real-time monitoring platforms, and strategic allocation for smart infrastructure. The planning accuracy increased from 60% to 85%, and budget mismatches decreased from 40% to 15%. However, the implementation still faces multidimensional challenges, including technical limitations (electrical infrastructure and internet connectivity), managerial gaps (absence of standard operating procedures for digital audits), human resource constraints (varying digital literacy among staff), and financial limitations (dependence on government funding and limited maintenance budget).

This study makes three principal contributions. **First**, it provides empirical evidence that digital transformation in infrastructure planning is feasible even in

state madrasahs with limited fiscal autonomy. The creative use of open-source platforms, peer-mentoring programs, and internal collaboration demonstrates that resource constraints can be overcome through strategic prioritization and collective commitment. **Second**, the study extends existing research on Islamic education management by highlighting the interconnected nature of challenges across technical, managerial, human resource, and financial dimensions. The findings demonstrate that digital innovation is not merely a technological matter but requires systemic alignment between infrastructure readiness, leadership commitment, and human resource development. **Third**, the study contributes to the theoretical discourse by applying the Resource-Based View (RBV) framework to understand how madrasahs can strategically manage both physical and digital assets to create competitive advantages, while integrating Islamic values of *amanah* (accountability) with modern management principles.

Practical implications for madrasah practitioners include the need for more substantive stakeholder participation in infrastructure planning, systematic approaches to digital asset management, sustained investment in technology infrastructure and staff training, and the development of comprehensive standard operating procedures for digital system maintenance and sustainability. The peer-mentoring model implemented at MI Negeri 2 Bandung Barat offers a replicable strategy for addressing human resource capacity gaps in resource-constrained institutions.

Theoretical implications include the need to refine models of infrastructure management in Islamic education to account for the unique characteristics of digital transformation. The findings suggest that existing frameworks may underestimate the institutional, cultural, and capacity-related barriers that shape implementation in madrasah contexts. The concept of *amanah* could be theorized more explicitly as a driver of digital innovation, linking spiritual values with managerial efficiency and transparency.

Policy implications for the Ministry of Religious Affairs and local education authorities include the need for differentiated support that recognizes the varying capacities of madrasahs. Providing standardized digital management systems and technical assistance could accelerate the transformation of under-resourced institutions. Additionally, policy incentives for madrasahs that demonstrate successful digital innovation could encourage broader adoption of best practices across the sector. The findings also suggest the need for investment in digital infrastructure at the district level to address connectivity and electrical limitations that constrain madrasah-level innovation.

This study has several limitations. **First**, as a single case study, the findings are context-specific and may not be generalizable to all madrasahs. The unique

characteristics of MI Negeri 2 Bandung Barat—including its leadership commitment, staff composition, and local support—may not be replicated in other settings. **Second**, the research focused primarily on qualitative data from a limited number of informants, which limits the ability to quantify the prevalence of identified challenges and their relative importance. **Third**, the study relied on self-reported data from interviews and observations, which may be subject to social desirability bias. **Fourth**, the research was conducted over a relatively short period, limiting the ability to observe long-term outcomes and sustainability of the digital innovation.

Future research should explore **comparative studies** across multiple madrasahs to identify patterns and variations in digital infrastructure management. **Longitudinal studies** tracking digital transformation over time would provide insights into change processes and long-term impacts. **Quantitative studies** measuring the relationship between digital infrastructure investment and student learning outcomes would complement qualitative findings. **Action research** involving practitioners as co-researchers could generate contextually grounded solutions to implementation challenges. **Research on effective models** of inter-institutional collaboration and government-madrasah partnership would inform policy strategies for scaling digital innovation. Additionally, future research should examine the differentiated impacts of digital innovation on various stakeholder groups, including teachers, administrative staff, students, and parents, to ensure that transformation efforts are inclusive and equitable.

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