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Analysis Policy Digitalization of Education

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Abstract
This study evaluates the effectiveness of equity and governance strategies in Indonesia's basic education digitalization policy (2019–2025). Utilizing a Systematic Literature Review (SLR) with the PICOC framework, the research analyzes 17 reputable journal articles and strategic policy documents. The results reveal a "technology paradox": despite strong legal foundations such as the National Education System Law and Presidential Instruction No. 7 of 2025 and successful administrative data integration, the uniform implementation approach exacerbates the digital divide, particularly in frontier, outermost, and least developed (3T) regions due to infrastructure disparities. Furthermore, the high adoption of the Independent Teaching Platform (PMM) reflects bureaucratic compliance rather than pedagogical motivation, resulting in cognitive burden for teachers. To address these challenges, the study recommends reorienting governance through asymmetric hybrid infrastructure strategies, strengthening digital leadership, and adopting life-cycle financing to ensure asset sustainability. Ultimately, national digital transformation must shift from merely modernizing administrative systems to fostering substantive educational quality.

Keywords: Digitalization, Policy, Education

Introduction

The Indonesian government has aggressively adopted digital transformation as a primary strategy to address the chronic issues of equitable access and quality in national education. This commitment is structurally reinforced by a robust legal framework, ranging from Law No. 20 of 2003 on the National Education System to the recent acceleration mandate through Presidential Instruction No. 7 of 2025 on the Acceleration of the Digitalization of Learning. Operational implementation is realized through the integration of digital ecosystems such as the *Merdeka Mengajar* Platform (PMM), Dapodik (Basic Education Data), and Computer-Based National Assessment (ANBK). However, a significant discrepancy remains between these macro-regulatory ambitions and the micro-realities in the field, particularly within basic education. Historical data indicates that Indonesia faces persistent quality challenges, a situation exacerbated by structural disparities between urban areas and the 3T (Frontier, Outermost, and Disadvantaged) regions.

Behind the policy optimism, the implementation of digitalization faces complex challenges that threaten to derail equity goals. Empirical studies by Judijanto, (2024) and Kudriani et al., (2023) highlight fundamental obstacles regarding the digital infrastructure gap, where connectivity in 3T regions lags significantly behind urban centers. Furthermore, the readiness of human resources remains uneven; teacher digital literacy is reported to be low, with significant competency gaps between age groups and regions. This creates a high risk of implementation failure where digital tools are deployed but not utilized effectively.

Existing literature has attempted to capture these dynamics, though often in a fragmented manner. Studies by Arbia & Amrullahb, (2024) and Hakim & Abidin, (2024) focus on the pedagogical aspects, emphasizing the need for holistic integration of character education. Conversely, Mavianti, (2025) and Pratama et al., (2025) reveal the psychological impacts, noting that digitalization increases access to information but simultaneously risks cognitive overload for teachers. More specific technical evaluations, such as those by Nur'aini et al., (2024) regarding PMM effectiveness, and Firdaus & Ritonga, (2024) on physical infrastructure constraints, provide valuable partial insights.

However, a significant research gap remains. The majority of previous studies tend to focus on evaluating the effectiveness of single policy instruments or are limited to specific case studies. There is a lack of comprehensive policy analysis using Systematic Literature Review (SLR) that dissects the "technology

paradox" a phenomenon where uniform policies designed for equity inadvertently widen inequality due to disregarded ecological disparities. Furthermore, the critical link between macro-regulations (Laws and Presidential Instructions) and micro-implementation realities (Total Cost of Ownership and psychosocial readiness) has not been sufficiently synthesized into integrated governance recommendations.

Addressing this urgency, this study aims to analyze Indonesia's digitalization policy for basic education in depth during the critical implementation period of 2019–2025. The specific objectives are: (1) To map the regulations and implementation strategies of digital education; (2) To identify challenges and successes holistically to detect systemic patterns; and (3) To synthesize findings to formulate governance recommendations that address the technology paradox and ensure equitable access. Through this approach, this research contributes to the formulation of more inclusive, evidence-based policies that move beyond administrative compliance to substantive educational improvement.

Method

SLR approach

This research applies the *Systematic Literature Review* (SLR) as the primary approach for collecting, evaluating, and synthesizing previous research findings on the implementation of educational digitalization policies in Indonesia and their impact on equity and learning quality. The SLR method was chosen for its superior ability to produce a more systematic, transparent, and structured literature review, thereby minimizing the potential for researcher bias and increasing the replicability of future research (Kitchenham, 2007). Unlike *narrative literature, reviews* are generally subjective and do not follow standard procedures. In contrast, SLR has clear stages: formulating research questions, conducting literature searches, selecting studies, extracting data, and synthesizing and analyzing the results.

The stages of implementing SLR in this research are as follows: a.) Formulation of Research Questions (*Research Questions – RQ*): Research questions are formulated using the PICOC framework (*Population, Intervention, Comparison, Outcome, Context*) to more clearly define the study's scope. With this framework, the research is focused on *the population* in the form of educational institutions and stakeholders in Indonesia; *intervention* in the form of the implementation of national digitalization policies (such as PMM, Dapodik, UTBK); *comparison*, namely comparison with conventional management or learning methods; *outcomes* in the form of governance efficiency, cultural transformation, and equal access; and *context* related to the national education system post-pandemic and the era of the industrial revolution 4.0. b.) Literature Search Strategy: Literature searches are conducted through leading academic databases, such as Scopus. Keywords are determined based on relevant terms, for example*, "digitalization of Indonesian education*", *"PMM implementation*", *"ANBK"*, *"DAPODIK"*, *"SPBE"*, and *"ICT implementation in Indonesian education "*. To ensure comprehensive search results, *Boolean was also used. Operators* (AND, OR) so that keyword combinations can expand or narrow the scope of articles found.

Literature Selection

The literature selection process was conducted systematically to ensure that only relevant, high-quality articles aligned with the research focus on education digitalization policy in Indonesia were analyzed further. The selection process is as follows:

Initial Identification

A literature search was conducted across leading academic databases using the keywords: "((digitalization of Indonesian education) OR (Indonesia's education digitalization policy) OR (PMM implementation) OR (ANBK) OR (DAPODIK) OR (SPBE) OR (ICT implementation in Indonesian education))". The search focused on publications from 2019 to 2025 to align with the latest policy trends. From this stage, 349 initial articles were obtained.

Screening Based on Title and Abstract (Screening)

At this stage, irrelevant articles were eliminated, such as research focused solely on technology without an educational context or studies outside the Indonesian context. The screening identified 249 articles for elimination.

Full Text Check (Eligibility)

Articles that passed the screening were then thoroughly reviewed to ensure they met the inclusion criteria, namely that they discussed government digitalization policies or program implementation. At this stage, 117 articles were eliminated because they did not meet the eligibility criteria (e.g., did not discuss specific policies or were not full text).

Selected Articles (Included Studies)

After a multi-layered selection process, 17 articles were identified that met all criteria and were worthy of analysis in this SLR.

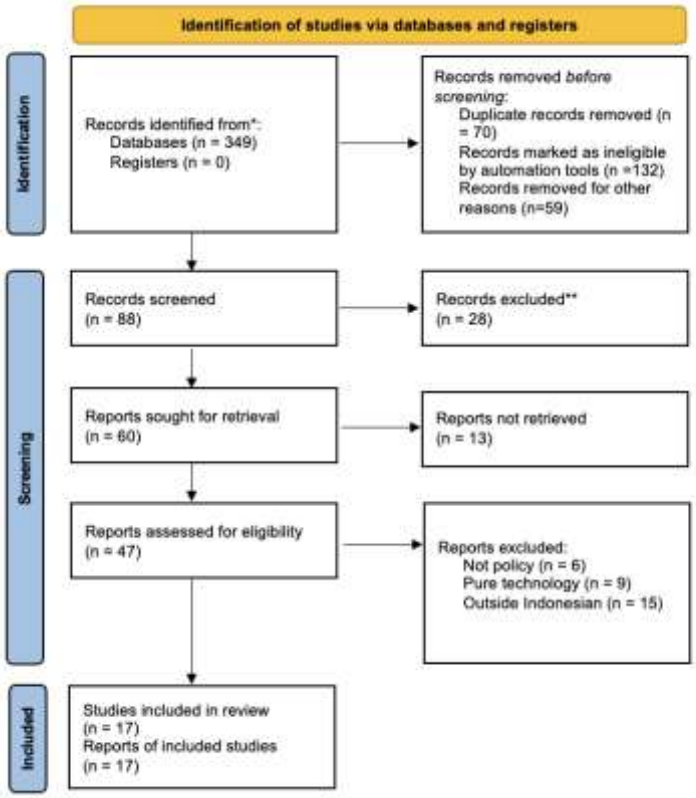

Figure 1. Prisma Diagram

Data Extraction

The selected articles were then analyzed by documenting important information through data *extraction. The* recorded data include the Author's identity, year of publication, research context, methods used, key findings related to policy implementation, and their implications for the national education system. The extraction form makes the information collection process more structured and facilitates comparisons between studies.

Synthesis and Analysis

The extracted information was analyzed using a thematic approach. This analysis aims to identify key patterns and trends in digitalization policies, including data governance and infrastructure, their impact on school culture and teacher competency, and the challenges posed by the digital divide. Through this approach, the study not only presents a summary of the article's content but also connects similar findings, highlights differences, and reveals areas that still require further policy review. By following this SLR stage, the study obtains a comprehensive picture of how the implementation of digitalization policies shapes educational transformation in Indonesia, while also revealing the structural obstacles to their implementation.

PICOC Framework

The PICOC (*Population, Intervention, Comparison, Outcome, Context*) framework is used to maintain a clear, focused research design. Each PICOC component is designed to help formulate appropriate research questions, guide the literature search, and direct the data analysis (Petticrew & Roberts, 2006).

Table 1. PICOC Structure of the Research

PICOC Element	Detailed Description	Relevance to Research
Population (P)	Educational institutions in Indonesia (Primary, Secondary, and Higher Education) and stakeholders (Teachers, Principals, Operators, and Education Offices).	Determining the unit of analysis in the form of the national education ecosystem impacted by digitalization regulations.
Intervention (I)	Implementation of the national education digitalization policy, including the Merdeka Mengajar (PMM) Platform, Dapodik, SPBE, UTBK, and the School Mover program.	It is the primary variable whose influence on governance and quality of learning is studied.
Comparison (C)	Conventional school management and learning practices (manual/paper-based) or the old selection system (UTBC).	Serve as a benchmark to assess the effectiveness of cultural transformation and administrative efficiency resulting from digitalization.
Outcome (O)	Improving digital competency, enhancing data governance efficiency, changing school culture, and identifying gaps (*digital divide*) and infrastructure challenges.	To be an indicator to assess the success and obstacles of implementing digitalization policies.
Context (C)	The Indonesian education system is in transition following the COVID-19 pandemic and the Industrial Revolution 4.0 era (2019–2025).	Provides boundaries of the socio-geographical context and time period of the policy.

Source: processed by the Author

By using this PICOC framework, the research questions that are the focus of this SLR can be formulated as follows:

RQ1: How are the strategies and forms of implementation of educational digitalization policies (such as Dapodik, PMM, and Kampus Merdeka) implemented at various levels of educational institutions in Indonesia?

RQ2: To what extent does the implementation of digitalization policies impact the transformation of school culture, leadership competency, and efficiency of educational administration governance?

RQ3: What are the structural and cultural challenges, such as infrastructure gaps and human resource readiness, that hinder the effectiveness of education digitalization policies in Indonesia?

Data Extraction and Synthesis

Data Extraction

The data extraction stage was conducted to gather essential information from each selected article. This process aimed to ensure that all relevant data related to the education digitalization policy could be thoroughly analyzed. The extracted data included author identity, year, title, research context, methods, key findings, and policy implications.

Data Synthesis

The synthesis was conducted by grouping the findings into key themes such as data governance (Dapodik/SPBE), digital infrastructure, platform ecosystems (PMM), digital evaluation (ANBK), and human resource development. The analysis highlighted the success of data integration and the challenges of infrastructure gaps in underdeveloped regions.

Table 2. Data Extraction Results of Selected Research

No	Author & Year	Article Title	Research Context	Research methods	Key Findings	Research Implications
1	Sholeh et al., (2025)	Digitalization of Education Policies in Indonesia...	Digitalization Policy (Independence to Teach) & ESD	Mixed methods	Reception has been positive, but there is a digital infrastructure gap in	The need for equitable allocation of digital resources and continuous teacher training.

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No	Author & Year	Article Title	Research Context	Research methods	Key Findings	Research Implications
					underdeveloped areas.	
2	Kudus et al., (2025)	"Learning from the past ...": transition of the higher education system	Transition of the PTN entrance selection system (colonial to UTBK)	Qualitative (Narrative)	UTBK technology enhances transparency, but the challenge of unequal access persists.	Evidence-based strategies are needed for inclusive selection technologies.
3	Syukur et al., (2024)	Integration of AI in Islamic Higher Education ...	AI Adoption in Islamic Universities in Indonesia vs. Thailand	Comparative qualitative	Indonesia views AI as a tool for modernization ; there is no formal AI curriculum yet.	AI integration needs to be explicitly included in curriculum policies.
4	Rohmadi et al. (2024)	Education Policy Implementation at School Level...	Implementation of education policy & digital social change	Descriptive qualitative	School strategy: curriculum adjustments & digital literacy address social impacts.	Government support is crucial for policy implementation at the school level.
5	Anggadwita et al. (2024)	Changes in Indonesian private universities ...	Post-pandemic private education practices	Qualitative (Interview)	Changes in digital practices continue; adaptability is key to behavioral readiness.	Policy recommendations for a post-crisis education system.
6	Kudus et al., (2024)	From print to pixels: institutional effects of transitioning ...	Transition of PTN selection (UTBC to UTBK)	Participatory research	Changes in organizational design from hierarchy to heterarchy in selection management.	Good business process management is required in the selection organization.
7	Saefullah et al. (2024)	Navigating uncertainty: future job forecasting ...	Independent Campus Policy (ICIL) & future work trends	Mixed method (SEM)	Projected work trends influence responsiveness and *graduate agility*.	The human resource development approach must emphasize technological adaptability.
8	Purnomo, (2023)	The Struggle of Formal Pasraman ...	Challenges of customary institutions & national data standards (Dapodik)	Qualitative	Pasraman is difficult to register in Dapodik due to regulatory administrative obstacles.	Data policies (Dapodik) must be more inclusive for local institutions.

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No	Author & Year	Article Title	Research Context	Research methods	Key Findings	Research Implications
9	Tias et al., (2022)	New School Culture in Post-COVID-19 Era...	New school culture of ICT use (Vice Principal's perspective)	Qualitative phenomenology	A new culture of technology use is emerging; innovative schools are becoming more adaptive.	A positive digital culture can address *learning loss* when applied widely.
10	Islamiyah et al. (2022)	Implementation of "School Mover Program"...	Driving School & Independent Learning Policy	Descriptive qualitative	Interventions include digitalization (PMM) and new paradigm learning.	School digitalization is a key intervention for the success of the new curriculum.
11	Novendra et al., (2022)	User Satisfaction Analysis ... of Dapodik Applications ...	Dapodik application users	Quantitative (Servqual)	Dissatisfaction with the empathy dimension; *tangible aspects* of the system need improvement.	The quality of data system services must be improved to assist operators.
12	Sujaya (2022)	Digital Leadership Competencies ... in Tasikmalaya...	Digital leadership competencies of school principals	Quantitative	Digital leadership has a positive impact on school innovation and quality.	School principals are required to develop digital competencies for transformation.
13	Ghafur (2021)	Analysis of ICT Development Supporting Learning ...	ICT Development at NU University	Qualitative	The main obstacle is management & HR support, not just connections.	The government needs to support ICT policies; universities need to evaluate their management.
14	Hadriana et al., (2021)	Online Learning Management ... at Junior High Schools ...	Online learning management for junior high school principals	Quantitative (SEM)	The implementation aspect is good, but planning and monitoring need improvement.	The government needs to provide facilities and training for online learning design.
15	Zamroni (2020)	Implementation of Educational Management Information System...	Implementation of SIM (Dapodik) in Middle Schools	Qualitative	SIM via Dapodik & ICT infrastructure supports education services.	Dapodik is crucial for data management and learning processes.
16	Pasani et al. (2020)	COVID-19 impact on Indonesia's	Impact of LFH policy & access gap	Policy analysis	The pandemic has widened the gap; ICT policies have	Management strategies are needed to address the

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No	Author & Year	Article Title	Research Context	Research methods	Key Findings	Research Implications
		education sector ...			been hampered by gradual implementation.	inequality of digital access.
17	Setiawan et al., (2020)	Meeting teachers' and learners' perceptions on mobile learning ...	*Mobile learning* perception in Vocational Schools & Curriculum 2013	Mixed method	Teachers and students are familiar with mobile ICT to support scientific approaches.	*Mobile learning* supports the implementation of a student-centered curriculum.

Source: processed by the Author

Data Synthesis

The data synthesis stage was conducted to integrate findings from 17 selected articles and provide a comprehensive understanding of the effectiveness, impacts, and challenges of implementing digital education policies in Indonesia. The synthesis process used a thematic approach: grouping research results by the study's primary focus, then comparing similarities, differences, and trends in policy patterns that emerged during the 2019–2025 period. Based on the data extraction results, the synthesis can be divided into three main themes that align with *the research. Questions* (RQ):

Strategy and Forms of Implementation of Digitalization Policy (RQ1)

Most articles emphasize that the government's strategy is shifting from a sectoral approach to centralized system integration. The primary implementation includes national data unification through the Basic Education Data (Dapodik) as the basis for budget and zoning policies. In the learning realm, interventions are implemented through the Merdeka Mengajar Platform (PMM), which serves as the primary tool for implementing the Merdeka Curriculum and the School Mover Program. At the higher education level, digitalization is being implemented through the transformation of the entrance selection system from paper-based to computer-based (UTBK) to ensure transparency, as well as the early adoption of artificial intelligence (AI) technology. However, it has not yet been formalized in the core curriculum. Furthermore, the distribution strategy for physical infrastructure (laptops and IFPs) and *mobile policies* is being implemented. *Learning* in vocational schools is also a significant focus in supporting national infrastructure standards.

Impact on School Culture and Governance Efficiency (RQ2)

Findings from various studies indicate that digitalization policy interventions have a significant impact on organizational culture transformation and administrative efficiency. Tias et al. (2022) and Sujaya (2022) emphasized the formation of a "new school culture" post-pandemic, where the principal's digital leadership competency is a determining factor in the school community's adaptability to technology. Administratively, the use of the Dapodik application and a computer-based selection system has been shown to increase data management efficiency and transparency in the student selection process. In the private sector, educators recognize that these changes in digital practices are permanent and encourage initiatives to increase engagement in the learning process.

Structural and Cultural Challenges in Implementation (RQ3)

Although acceptance of digitalization tends to be positive, fundamental challenges still hinder equitable quality. Sholeh et al. (2025) and Pasani et al. (2020) highlighted the extreme digital infrastructure gap between urban and underdeveloped regions (3T), which has the potential to widen the disparity in educational quality. From a human resources perspective, Ghafur (2021) and Hadriana et al. (2021) found that the main obstacle was not just internet connectivity, but also a lack of management support and teacher competency in designing online learning. Furthermore, there were exclusive regulatory barriers, such as the difficulty of local religious educational institutions integrating into the national data system (Dapodik).

Overall Synthesis

The synthesis of these findings demonstrates that the implementation of Indonesia's digital education policy has successfully built a foundation for more integrated and efficient governance and fostered adaptive cultural change in schools. However, the policy's substantive success remains partial and highly dependent on the availability of basic infrastructure and the competence of local leadership. Overall, digital education

currently faces a technological paradox: interventions intended to promote equity can exacerbate inequality if not accompanied by affirmative action strategies for disadvantaged regions and a sustainable approach to human resource development.

RESULTS AND DISCUSSION

3.1 Mapping of Digitalization Regulations and Implementation

The literature mapping findings confirm a shift in the policy paradigm from voluntary adoption to structured regulatory mandates. The legal foundation for digital education is strengthened by Presidential Regulation No. 95 of 2018 (SPBE) and Presidential Regulation No. 39 of 2019 (One Data Indonesia), which make data integration a primary prerequisite. The peak of acceleration is seen in Presidential Instruction No. 7 of 2025, which explicitly instructs accelerating the provision of physical and digital infrastructure. Table 1 below summarizes the hierarchy of these regulations, from the philosophical foundation (the National Education System Law) to the technical instruments (the Regulation of the Minister of Education, Culture, Research, and Technology and the Regulation of the Minister of Administrative and Bureaucratic Reform).

Table 3. Regulatory Framework for Educational Digitalization Policy (2003-2025)

Regulation Level	Legal Instruments	Key Focus & Relevance
Foundation (Mandate)	Law No. 20/2003 (National Education System)	Require the use of ICT to equalize educational quality.
Governance	Presidential Decree No. 95/2018 (SPBE)	Integration of ministry digital services (Dapodik, PMM, ARKAS).
	Presidential Decree No. 39/2019 (One Data)	Determination of Dapodik as a single data *reference source of truth*.
Acceleration	Presidential Instruction No. 7/2025	Presidential Instruction for massive acceleration of physical and digital infrastructure.
Fiscal	Presidential Decree No. 57/2024	Technical Instructions for Physical DAK for the procurement of ICT equipment in the regions.
	Minister of Education and Culture Regulation No. 63/2023	Flexibility of BOS Funds for operational and internet costs.
Implementation	Minister of Education and Culture Regulation No. 12/2024	PMM is the primary tool for implementing the Independent Curriculum.
	Minister of Administrative and Bureaucratic Reform Regulation No. 1/2023	Integration of PMM with the teacher performance management system (e-Kinerja).

The regulatory mandate is translated into three main implementation pillars that demonstrate both success and challenges. First, in terms of data governance, strengthening Dapodik as a single data source has proven successful in increasing school administrative efficiency (Zamroni, 2020). However, inclusivity challenges remain, particularly for traditional educational institutions that are difficult to accommodate within the system (Purnomo, 2023). Second, in terms of learning transformation, the adoption of the Merdeka Mengajar (PMM) Platform has shown a positive trend in supporting the Merdeka Curriculum, particularly in pioneering schools (Islamiyah et al., 2022). However, its effectiveness in the field varies widely and is highly dependent on school principals' digital leadership competency (Sujaya, 2022). Third, regarding the modernization of the transition evaluation from the National Examination to ANBK and digital assessment has increased the transparency of selection (Kudus et al., 2024); however, the adoption of advanced technologies such as artificial intelligence (AI) was found to be still limited to operational aspects and has not touched the core curriculum (Syukur et al., 2024).

Overall, this mapping confirms that the government has successfully built the foundations of an integrated digital ecosystem, from data governance to modernizing learning and evaluation. However, findings regarding obstacles to administrative inclusivity and variability in technology adoption at the educational unit level indicate that the existence of regulations and digital platforms alone does not guarantee uniform implementation quality. This reality serves as a crucial starting point for further analysis of implementation dynamics and the inhibiting factors that create gaps between policy mandates and on-the-ground conditions.

3.2 Identifying Successes and Challenges

The implementation of digitalization has demonstrated significant success in modernizing governance. Studies by Zamroni (2020) and Novendra et al. (2022) confirm that Dapodik has successfully become the backbone of efficient school administration and fostered a culture of Data-Based Planning (PBD). In higher education, the UTBK selection system has been shown to increase transparency and accountability in student admissions (Kudus et al., 2025). However, data validity challenges persist due to reliance on operator competence and the issue of system exclusivity, which traditional educational institutions have not yet accommodated (Purnomo, 2023). Culturally, the post-pandemic period has created a "new school culture" that is more adaptive to technology (Tias et al., 2022). Culturally, the post-pandemic period has created a "new school culture" that is more adaptive to technology, with the School Mover Program and PMM as key catalysts. This positive acceptance is reinforced by the findings of Setiawan et al. (2020), which show that *mobile integration supports effective learning* by leveraging user familiarity with mobile devices. However, the reality on the ground shows a sharp disparity: while young teachers are adaptive, senior teachers experience *technostress* and cognitive burden due to application demands. On the infrastructure side, the success of massive hardware distribution is recognized as strengthening the digital ecosystem. However, the access gap in the 3T regions, especially limited electricity and internet access, remains a structural barrier that creates sustainability risks and triggers paradoxical patterns of implementation across regions. The following table summarizes the comparison of ecosystem readiness between established and underdeveloped areas.

Table 4. Implementation Paradox: Comparison of Ecosystem Readiness of Established vs. 3T Areas

Ecosystem Indicators	Established Area (Java/Urban)	3T (Underdeveloped, Frontier, Outermost) Regions
Basic Infrastructure	Stable. 24-hour electricity & Fiber Optic available.	Critical. Power outages are common, and the screen *goes blank.* Internet *spot*.
Asset Utilization	Active. Device used for *Hybrid Learning*.	Passive. Devices pile up in a warehouse ("Technology Graveyard").
PMM Adoption	Substantive. Used for learning innovation.	Administrative. simply fulfilling e-Performance obligations.
Teacher Resilience	High. Rapid technology adaptation.	Low. High *technostress* due to the generation gap.
Funding Support	Enough. BOS is sufficient for equipment maintenance.	Deficit. BOS funds are used up for honorary salaries; there are no maintenance costs.

3.3 Synthesis of Findings

Patterns of Success: Visionary Leadership and Cultural Adaptability

A cross-study synthesis reveals that successful digitalization does not happen by chance; rather, it depends heavily on the quality of leadership and organizational culture. Successful educational institutions are led by visionary principals who can orchestrate the digital ecosystem rather than serve as administrators (Sujaya, 2022). An adaptive school culture is also key; schools that are open to change are quicker to integrate technologies such as mobile learning. Learning and PMM effectively (Tias et al., 2022; Islamiyah et al., 2022). At the higher education level, organizational agility in responding to change is more decisive for the success of digital transformation than the availability of physical infrastructure (Anggadwita et al., 2024; Ghafur, 2021).

Failure Pattern: Ecosystem Mismatch

Conversely, implementation failures consistently occur when the adopted technology mismatches the local ecosystem's readiness. Studies by Sholeh et al. (2025) and Pasani et al. (2020) highlight that in 3T areas, cloud-based interventions often fail due to the lack of basic infrastructure (internet and electricity). Uniform (one-size-fits-all) policies ignore this disparity, preventing the optimal use of advanced technologies.

Sustainability Challenges: Fiscal Risks and the TCO Trap

The in-depth analysis also revealed serious fiscal risks related to the program's sustainability. The *Total Cost Concept of Total Cost of Ownership* (TCO) shows that the initial purchase cost (CapEx) is only a small portion of the total technology lifecycle costs. As illustrated in Figure 2, non-physical cost components (maintenance, teacher training, connectivity) account for the most significant share of the budget (75%) but are often overlooked in school budget planning.

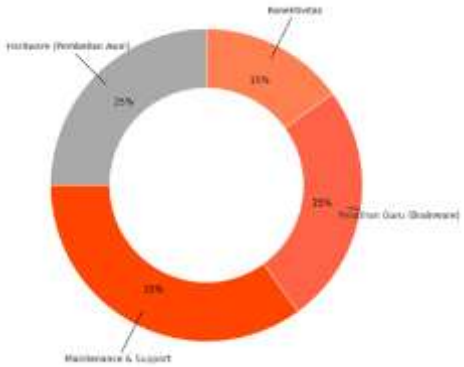

Figure 2. Composition of Technology Life Cycle Costs

The dominance of investment in *hardware capital expenditures without adequate operational budget (* Opex) support creates the risk of a "technology graveyard," where digital devices in aided schools end up abandoned or damaged beyond repair. These findings underscore the need for more holistic budget governance reform.

Discussion

4.1 Implementation Dynamics

The Gap Between Statutes and Environmental Variables

Mazmanian & Sabatier's (1983) implementation theory (Mazmanian & Sabatier, 1983)holds that the success of a policy is determined by the ability of the statute (regulation) to structure the implementation process amid the complexity of the problem. The analysis shows that the statute governing Indonesia's digitalization policy is relatively strong in terms of resource mobilization, as evidenced by the massive procurement of devices under Presidential Instruction No. 7 of 2025. However, this policy faces implementation failure in terms of controlling non-statutory variables (environment). Uniform central regulations fail to anticipate ecological disparities in the field. As noted by Badaruddin et al. (2025), the inequality in basic infrastructure in the 3T region is an environmental variable that cannot be resolved simply by distributing laptops. In Grindle's (1980) logic, the ideal "policy content" becomes ineffective due to inadequate "implementation context" (regional carrying capacity).

The Paradox of Technology as an Impact of Implementation

The dynamics of the failure to control these environmental variables give rise to the technological paradox. Policy interventions designed for equity actually trigger divergence in quality. Schools in established areas (Java/urban areas), supported by a mature digital ecosystem, can utilize PMM and ICT tools to accelerate learning innovation (hybrid). Learning). Conversely, in 3T regions, sophisticated devices often become passive assets due to the lack of a supporting ecosystem. This phenomenon confirms that without an asymmetrical implementation approach, digitalization actually widens the quality gap in national education.

4.2 Attitudes and Acceptance of Policy Implementers

Pseudo Compliance

Horn's implementation theory framework shows that the high adoption of PMM reflects more administrative compliance than acceptance of pedagogical value. Teachers are driven to use the platform by regulatory pressures for e-Performance rather than by intrinsic motivation to innovate (Ketaren et al., 2022). This phenomenon creates pseudo-compliance and technostress, especially among senior teachers who experience difficulties with adaptation (Hadriana et al., 2021). This explains why, despite the high number of active users, the impact on classroom learning quality is not necessarily significant. The biggest challenge for human resources today is not merely technical skills, but rather an adaptable mentality. In line with the findings of Saefullah et al. (2024), in the context of future work trends, digitalization demands learning agility and high responsiveness from educators. Therefore, teacher development should not stop at administrative compliance with the application, but must be directed at developing an adaptive character towards technology.

The Central Role of Local Leadership

The success of implementation at the micro level depends heavily on the principal's leadership capacity. A study by Timan & Imron (2022) found that principals with a strong digital vision can mitigate technical barriers and motivate teachers. Conversely, conventional administrative leadership tends to stall policy implementation at the reporting stage without orchestrating substantive changes in the learning culture (Nurrochman et al., 2023).

4.3 Policy Implications and Recommendations

Findings on implementation failures due to ecosystem mismatches in the 3T regions call for a paradigm shift in infrastructure policy. *A one-stop approach, size-fits-all. Systems* that rely on cloud-based technology have proven ineffective in areas with low connectivity (Sholeh et al., 2025; Pasani et al., 2020). Therefore, an Asymmetric Hybrid Infrastructure strategy is needed. The government can no longer enforce the same technology standards between Jakarta and Papua. For 3T regions, priority must shift to Offline-First technology, such as the use of local servers (school-in-a-box) that contain learning content (videos, digital books), accessible via an intranet without an external internet connection (Ganefri et al., 2019). This strategy ensures that the right to access quality materials is upheld even though the national internet infrastructure is unevenly distributed.

Success patterns based on school leadership and culture indicate that technological interventions are only successful when accompanied by human readiness (Sujaya, 2022; Tias et al., 2022). However, high levels of technostress among teachers indicate design flaws in human resource management (Pradani et al., 2022; Haeri & Afriansyah, 2024). This discussion recommends decoupling learning activities in PMM from administrative performance assessments (Ketaren et al., 2022). Teachers should be freed from the pressure of pursuing certification so they can focus on substantive innovation. Furthermore, the isolating model of independent training needs to be replaced with community-based mentoring (peer-based mentoring). Coaching), where the principal acts as a learning leader (instructional leader) who facilitates collaboration rather than merely monitors administrative compliance (Nurrochman et al., 2023).

A TCO analysis revealing the dominance of hidden costs (75%) confirms that the current funding model is unsustainable. The risk of a "technology graveyard" arises because the school budget (BOS) is not designed to cover the operational costs of high technology. An urgent policy solution is to implement the Life Cycle principle. Financing. Physical Special Allocation Fund (DAK) regulations should be revised to require procurement packages to include a long-term (3-5 year) after-sales service contract (warranty & support) at the outset of the purchase. Furthermore, the central government needs to earmark a dedicated budget item within the Performance Operational Assistance Fund (BOS) for digital operations (electricity and internet), to prevent them from being eroded by personnel expenditures. To summarize these strategic steps, Table 3 below presents a matrix of recommended policy solutions.

Table 5. Educational Digitalization Policy Optimization Strategy Matrix

Problem Dimensions	Optimization Strategy (Policy Solution)	Target Outcome
Infrastructure Gaps (3T Paradox)	Hybrid (Asymmetric) Approach: Prioritize local server technology (*offline-first*) for 3T areas; Convergence with solar power supply.	Access equivalent materials without relying on an internet connection.
Human Resource Competence (Cognitive Load)	Decoupling & Peer Coaching: Separate PMM learning from e-Performance; Transform self-paced training into peer mentoring in schools.	Teacher motivation shifts from administrative to pedagogical.
Financial Governance (TCO Risk)	Life Cycle Financing: Requires a procurement package and a 3-5-year warranty; *earmarks* dedicated digital operational funds.	Maintaining asset sustainability; Preventing a "technology graveyard".
Leadership (Passive Managerial)	Digital Instructional Leadership: Revitalizing the role of school supervisors to assist school principals in change management.	Adaptive and innovative school culture.

Conclusion

Analysis of the digitalization of education policy in Indonesia reveals a crucial paradox. Although strong regulatory frameworks and quantitative achievements, such as the adoption of PMM and ICT infrastructure, show a positive trend, failures in control variables and the local ecosystem create a sharp gap between established areas and 3T. Interventions that are uniformly proven to be effective, in fact risky, create a "grave" technology due to the absence of a life-cycle financing scheme and unpreparedness, and an infrastructure basis. Therefore, it is necessary to reorient fundamental policies through an infrastructure strategy, an asymmetric hybrid, a separation between development teacher competence and administration performance, as well as revitalization of digital leadership at the school level. Digital transformation does not stop at the mobilization of devices; it must become an orchestration of an adaptive and inclusive ecosystem to realize substantive equality in quality education.

Limitations Study

Study its own limitations, as it uses the *Systematic Literature Review* (SLR) method, which relies solely on secondary data without field verification, thereby failing to capture nuanced dynamics in real time. Reliance on literature publications also raises the risk of bias, a challenge that, specifically in the 3T region, has not yet been documented comprehensively. In addition, the evaluation of regulations, as of 2025, remains predictive and requires more longitudinal studies to measure impact over time with greater accuracy.

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