

Transformation of Village Digital Governance through Digital Literacy Education Program in the Implementation of Smart Villages in Indonesia

Pegi Sugiartini

Universitas Muhammadiyah Cirebon, Indonesia
Corresponding Author : pegisugiartini@gmail.com

Article Info :	ABSTRACT
Accepted: 05-08-2025	The digital transformation of village governance is essential for the successful implementation of Smart Village initiatives in Indonesia. Despite the government's efforts, challenges remain, including low digital literacy among village officials and infrastructure limitations. This study aims to explore how village leadership drives digital transformation through digital literacy education programs within the Smart Village framework. A mixed-methods approach was employed, combining quantitative surveys with qualitative case studies across 45 villages in Indonesia. The research identifies the significant role of transformational leadership in facilitating digital governance, showing that leaders who actively engage with and support digital literacy programs achieve higher participation and completion rates. Key findings reveal that digital literacy programs significantly improve village administrative capacity, including data management, e-governance, and transparency. The research highlights leadership competencies, such as vision articulation and stakeholder mobilization, as critical drivers of success. The study concludes that leadership-driven digital literacy education is crucial for bridging the digital divide, enhancing governance efficiency, and ensuring the sustainability of Smart Village initiatives. Recommendations include investing in leadership development and tailored digital literacy programs to foster inclusive digital transformation in rural areas.
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INTRODUCTION

The digital transformation of rural governance has emerged as a critical phenomenon in developing countries, particularly in Indonesia, where approximately 74,961 villages are undergoing significant administrative and technological transitions (Mayyora et al., 2025; Misra et al., 2021; Qin et al., 2022; Siswanti et al., 2024; Yuliana & Natalia, 2025; Zhu, 2023). The Indonesian government's ambitious Smart Village initiative, launched as part of the national digitalization agenda, aims to modernize rural governance structures and enhance public service delivery through digital technologies. However, this transformation faces substantial challenges, as evidenced by the Ministry of Villages, Development of Disadvantaged Regions, and

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Transmigration's 2023 report indicating that only 18% of village governments have successfully integrated digital systems into their governance practices (Fauziyyah et al., 2025). This digital divide is further exacerbated by the limited digital literacy among village officials, with studies showing that 67% of village government apparatus lack adequate digital competencies to manage e-governance systems effectively (Faozanudin et al., 2023, 2025; Huang et al., 2025; Rismayani et al., 2025; Zhang et al., 2025).

The phenomenon becomes increasingly crucial as villages serve as the foundation of Indonesia's administrative system, directly affecting 43.5% of the national population residing in rural areas (Ushaka Adie et al., 2024). The inadequate digital transformation in village governance not only hampers administrative efficiency but also impedes citizen participation, transparency, and accountability in local decision-making processes. Furthermore, the COVID-19 pandemic has accelerated the urgency for digital governance, as traditional face-to-face administrative processes became severely disrupted, exposing the vulnerability of villages with insufficient digital infrastructure and literacy. This situation demands immediate attention from both academic and policy perspectives, as the success of Indonesia's broader digital economy roadmap and sustainable development goals heavily depends on the effective digital transformation of village governance.

Previous studies have extensively examined digital governance implementation in rural settings across various contexts. Naldi et al. (2015) investigated digital development strategies in peripheral regions, identifying infrastructure limitations as primary barriers. Khan et al. (2014) analyzed e-governance adoption in South Asian rural areas, highlighting the importance of institutional capacity. Gil-Garcia et al. (2018) examined the challenges of implementing digital government services in developing countries, focusing on technological readiness. However, these studies predominantly focused on technological infrastructure and institutional frameworks, with limited attention to the human capacity development aspects, particularly the role of leadership in driving digital transformation at the grassroots level.

The second stream of literature addresses digital literacy development and capacity building initiatives. Gil-Garcia et al. (2018) analyzed digital skills gaps and their implications for social inequality, emphasizing the multidimensional nature of digital literacy. Guillén-Gámez et al. (2021) examined the differences in digital competencies among various demographic groups, revealing significant variations based on age and education. Martin et al. (2024) explored the digital divide in rural communities, identifying educational interventions as crucial mitigating factors. While these studies provide valuable insights into digital literacy development, they predominantly treat digital skills as individual competencies rather than examining how systematic digital literacy education programs can transform organizational governance structures, particularly in village government contexts.

Research on transformational leadership in public sector digitalization has gained attention in recent years. Mergel et al. (2019) explored leadership

roles in driving digital innovation in government organizations, emphasizing change management capabilities. Dwivedi et al. (2017) examined critical success factors for e-government implementation, identifying leadership commitment as a key determinant. Luna-Reyes & Gil-Garcia (2014) investigated collaborative leadership in inter-organizational digital government initiatives, highlighting coordination challenges (KUIPERS et al., 2014) analyzed leadership in public sector organizational change, revealing the importance of adaptive leadership styles. Despite these contributions, existing literature lacks comprehensive examination of how village-level leadership specifically orchestrates digital transformation through structured digital literacy programs, particularly in the context of implementing smart village initiatives in developing countries like Indonesia.

The review reveals three critical gaps in existing literature. First, while studies address digital governance and smart village concepts separately, there is insufficient research examining the intersection of transformational leadership, digital literacy education, and smart village implementation in developing country contexts. Second, previous research has predominantly focused on urban or national-level digital transformation, with limited attention to village-level governance dynamics and the unique challenges faced by grassroots leaders. Third, the literature lacks empirical evidence on how systematic digital literacy education programs, when strategically led by village leadership, can serve as catalysts for comprehensive digital governance transformation, bridging the gap between policy intentions and implementation realities.

This research aims to comprehensively examine the role of transformational leadership in digital village governance through digital literacy education programs within Indonesia's Smart Village implementation framework. Specifically, this study seeks to analyze how village leadership facilitates digital governance transformation by designing and implementing strategic digital literacy education programs for village government apparatus and community members, investigate the mechanisms through which digital literacy education programs enhance village administrative capacity, transparency, and public service delivery in the context of smart village initiatives, identify leadership competencies and strategies that effectively drive digital transformation at the village level, considering the unique socio-cultural, economic, and institutional contexts of Indonesian rural communities and evaluate the outcomes and impacts of leadership-driven digital literacy programs on village governance performance, citizen engagement, and the overall success of smart village implementation.

This research offers significant theoretical, methodological, and practical contributions. Theoretically, it advances the understanding of transformational leadership in digital governance contexts by developing an integrated framework that connects leadership practices, digital literacy development, and organizational transformation at the grassroots level. The study contributes to bridging public administration, development studies, and information systems literature by demonstrating how village-level leadership

can serve as a critical mediating factor between national digital policies and local implementation outcomes. Methodologically, this research employs a mixed-methods approach that combines qualitative case studies of successful smart village implementations with quantitative assessments of digital literacy impacts, providing robust empirical evidence for understanding complex leadership-technology-governance relationships in rural contexts.

Practically, the findings will inform policy makers, village governments, and development practitioners about effective leadership strategies and digital literacy program designs that can accelerate smart village implementation across Indonesia's diverse village contexts. The research will produce actionable recommendations for strengthening village leadership capacity, optimizing digital literacy curriculum development, and designing supportive institutional frameworks that enable sustainable digital transformation in rural governance.

Furthermore, this study's insights can be adapted for other developing countries facing similar challenges in rural digital transformation, contributing to the global discourse on inclusive digital development and smart rural communities. This research argues that effective digital village governance transformation is primarily driven by leadership, not just technology. Specifically, transformational leadership through inspirational motivation, intellectual stimulation, individualized consideration, and idealized influence plays a key role in navigating digital transformation. The study hypothesizes that:

1. Transformational leadership positively influences the success of digital literacy programs, with stronger leadership resulting in higher participation, completion rates, and skill acquisition.
2. Strong village leadership, coupled with digital literacy education, enhances digital governance capabilities, such as improved administration, data management, and e-governance use.
3. The interaction of transformational leadership and high-quality literacy programs leads to greater success in smart village implementation.
4. Leadership-driven literacy programs improve village governance outcomes, including transparency, service efficiency, citizen participation, and accountability.

In summary, this study addresses a critical gap in understanding digital transformation at Indonesia's grassroots governance level, where 74,961 villages face significant challenges in implementing Smart Village initiatives despite national policy support. The research responds to three key gaps in existing literature: (1) insufficient examination of the intersection between transformational leadership, digital literacy education, and smart village implementation in developing countries; (2) limited attention to village-level governance dynamics and unique challenges faced by grassroots leaders; and (3) lack of empirical evidence on how systematic digital literacy programs, when strategically led by village leadership, can catalyze comprehensive digital governance transformation. This research employs a mixed-methods

approach across 45 Indonesian villages to examine how transformational leadership drives digital governance through strategic digital literacy education programs within the Smart Village framework.

The study tests four hypotheses linking transformational leadership to digital literacy program success, digital governance capacity enhancement, smart village implementation outcomes, and overall village governance performance. By integrating theoretical frameworks from public administration, development studies, and information systems, this research contributes both conceptually and practically to understanding leadership-technology-governance relationships in rural contexts, with actionable insights for policy makers and practitioners seeking to accelerate inclusive digital transformation in developing country villages.

RESEARCH METHOD

This research uses a multi-level unit of analysis approach to examine the transformation of digital village governance through leadership and digital literacy education programs. The three main units of analysis are: first, at the individual level, focusing on village heads and government apparatus involved in digital literacy programs, examining their transformational leadership characteristics, digital competencies, and behavioral changes in adopting digital governance practices. Second, at the organizational level, the analysis centers on the digital governance capacity of village government institutions, administrative digitalization processes, e-governance platform usage, and organizational readiness for digital transformation.

Third, at the program level, the study analyzes digital literacy education programs as intervention mechanisms, investigating their design features, implementation strategies, and outcomes in building digital capacity among village stakeholders. The research also includes a community-level analysis, examining citizen engagement patterns in digital governance platforms and public perceptions of digital service improvements. This study employs a mixed-methods design combining quantitative and qualitative approaches, starting with a quantitative survey of 450 village officials across 150 villages in diverse geographical and developmental contexts in Indonesia, followed by qualitative case studies in 12 purposively selected villages. The integration of mixed methods occurs at the interpretation stage to provide a more holistic understanding of the phenomenon.

Data Sources and Information

This research utilizes various data sources to ensure comprehensiveness and triangulation. Primary data sources include: Survey respondents – 450 village government officials, including village heads (150), village secretaries (150), and heads of village affairs sections (150), Key informants for in-depth interviews – 36 participants consisting of village heads (12), digital literacy program facilitators (12), and community leaders (12), Focus group discussion participants – 72 village government apparatus members (six groups of 12 participants each) and Community informants – 48 citizens (four

per case study village). Secondary data sources include: Official documents, such as smart village implementation reports, digital literacy program curricula, village government regulations on digital governance, and performance evaluation reports from the Ministry of Villages; Administrative records, such as village financial management system data, e-governance platform utilization statistics, and citizen service delivery records; Policy documents, including national smart village guidelines and digital village roadmaps; and Audiovisual materials, such as photographs of digital infrastructure and video recordings of digital literacy sessions. The combination of these diverse data sources enables strong triangulation, enhancing the validity and reliability of the research findings while capturing multiple perspectives on the digital governance transformation.

Data Collection Techniques

Data collection in this study involves both quantitative and qualitative methods. The quantitative phase uses a structured survey administered through computer-assisted personal interviewing (CAPI), incorporating five validated instruments: the Multifactor Leadership Questionnaire (MLQ) adapted for Indonesian villages, a Digital Literacy Program Effectiveness Scale, a Digital Governance Capacity Index, a Smart Village Implementation Success Scale, and a Village Governance Performance Instrument. Trained enumerators conduct face-to-face interviews to ensure data quality and accuracy. The qualitative phase involves semi-structured in-depth interviews with key informants, Focus Group Discussions (FGDs), document analysis, and participatory observation. Interviews and FGDs explore leadership practices, digital transformation, program experiences, challenges, and success factors. Data is transcribed, documented, and analyzed. Ethical protocols, including informed consent and confidentiality, are strictly followed.

Data Analysis

Data analysis follows systematic procedures appropriate to the type of data and research phase. For quantitative data, the first stage involves data cleaning, handling missing values using expectation-maximization algorithms, outlier detection using Mahalanobis distance, and normality assessment through skewness and kurtosis statistics. The second stage is descriptive statistical analysis to calculate frequencies, percentages, means, and standard deviations to provide demographic profiles of respondents and patterns of key constructs. The third stage is measurement model assessment using confirmatory factor analysis (CFA) to evaluate construct validity, including examining factor loadings (>0.70), composite reliability (CR >0.70), and average variance extracted (AVE >0.50). Discriminant validity is assessed using the Fornell-Larcker criterion.

The fourth stage is structural equation modeling (SEM) to test the relationships between variables, with model fit evaluated using multiple indices. The fifth stage is mediation analysis using bootstrapping procedures to examine the indirect effects of leadership on smart village outcomes

through digital literacy programs and governance capacity. The sixth stage is moderation analysis to test interaction effects between leadership quality and program characteristics on outcomes. For qualitative data analysis, the first step involves familiarization with the data through repeated reading and note-taking. Next, open coding is conducted to identify meaningful segments and assign descriptive codes using NVivo 14 software.

Then, axial coding organizes initial codes into broader categories related to leadership practices, transformation strategies, implementation challenges, and success factors. Selective coding identifies core categories and develops conceptual relationships among themes. Constant comparison analysis is used to compare data within and across cases. Pattern matching compares emergent qualitative themes with quantitative findings. Document analysis is conducted using content analysis and thematic analysis to identify recurring patterns in policy discourses and institutional documents. Mixed-methods integration occurs through data transformation, creation of joint displays, and meta-inference development to synthesize findings across both methods comprehensively. Throughout the analysis process, reflexivity is maintained through researcher journaling and team debriefing sessions, while member checking with selected participants and triangulation across data sources, methods, and researchers enhances the credibility of the findings.

RESULT AND DISCUSSION

This section presents empirical findings from a mixed-methods investigation conducted across 45 selected villages in Indonesia implementing Smart Village initiatives between January 2023 and October 2024. The research employed a convergent parallel design, combining quantitative surveys (n=450 village officials and 900 community members), in-depth interviews (n=67 village leaders and key stakeholders), document analysis of digital literacy program curricula and implementation reports, and observational data from digital governance practice assessments. The selection of villages represented diverse geographical contexts (Java, Sumatra, Sulawesi, and Kalimantan) and varying levels of digital infrastructure maturity, ensuring comprehensive representation of Indonesia's rural diversity.

Village Leadership Facilitation of Digital Governance Transformation through Strategic Digital Literacy Programs

Data Presentation

The first objective examined how village leadership facilitates digital governance transformation through the design and implementation of strategic digital literacy education programs. Data collected from 45 villages revealed significant variations in leadership approaches and program implementation strategies. Quantitative assessments using the Transformational Leadership Inventory (TLI) showed that village heads scored between 2.8 to 4.6 (M=3.74, SD=0.52) on a 5-point scale, with 62% demonstrating high transformational leadership characteristics (scores ≥ 4.0).

Digital literacy program implementation quality, measured through the Digital Education Program Effectiveness Scale (DEPES), ranged from 2.3 to 4.8 ($M=3.58$, $SD=0.61$), indicating considerable variation in program design and execution quality.

Interview data with 32 village heads revealed four distinct leadership approaches to digital transformation: (1) Visionary Initiators ($n=12$, 37.5%), who personally championed digital transformation and invested significant time in program design; (2) Collaborative Facilitators ($n=11$, 34.4%), who established multi-stakeholder teams to co-create digital literacy initiatives; (3) Delegative Coordinators ($n=6$, 18.8%), who assigned digital transformation responsibilities to designated officials; and (4) Reactive Responders ($n=3$, 9.3%), who implemented programs primarily due to external mandates. Documentary analysis of 45 digital literacy program curricula revealed that 73% included modules on basic digital skills, 82% incorporated e-governance platform training, 56% featured data management components, and only 38% integrated digital ethics and cybersecurity awareness.

Observational assessments of leadership engagement in program implementation documented that village heads in high-performing villages ($n=18$) invested average of 8.7 hours per week directly in digital literacy activities, compared to 3.2 hours in medium-performing ($n=17$) and 1.4 hours in low-performing villages ($n=10$). Participant observation during 23 training sessions revealed that leadership presence significantly influenced participant engagement, with attendance rates averaging 87% when village heads actively participated versus 64% when leaders were absent.

Table 1. Correlation between Leadership Approaches and Program Implementation Effectiveness

Leadership Type	N	TLI Score (M±SD)	DEPES Score (M±SD)	Participation Rate	Completion Rate
Visionary Initiators	12	4.42±0.28	4.31±0.35	89.3%	82.7%
Collaborative Facilitators	11	4.18±0.31	4.12±0.41	85.6%	78.4%
Delegative Coordinators	6	3.45±0.38	3.28±0.47	71.2%	65.3%
Reactive Responders	3	2.93±0.42	2.67±0.52	58.7%	51.2%
Overall	32	3.94±0.58	3.76±0.64	81.4%	74.6%

Note: TLI = Transformational Leadership Inventory; DEPES = Digital Education Program Effectiveness Scale; Scores range from 1-5.

Restatement

The findings demonstrate that village leadership approaches to digital transformation vary substantially across Indonesian villages, with the majority of effective village heads adopting proactive, visionary, or

collaborative leadership styles. Those village leaders who personally champion digital initiatives and invest considerable time in program design and implementation achieve significantly higher program participation and completion rates compared to leaders who delegate responsibilities or respond reactively to external mandates. The data clearly show that transformational leadership qualities correlate positively with digital literacy program effectiveness, as measured by both program quality assessments and participant outcomes.

Description of Patterns

Four distinct patterns emerge from the data. First, leadership commitment intensity demonstrates a dose-response relationship with program effectiveness, where villages with leaders scoring above 4.0 on transformational leadership scales consistently achieved program completion rates exceeding 75%, while those below 3.5 rarely surpassed 60% completion. This pattern suggests that leadership engagement serves as a critical threshold variable in program success. Second, program design comprehensiveness varies systematically with leadership approach, with Visionary Initiators developing curricula averaging 47 instructional hours across 8-12 modules, compared to 26 hours across 4-6 modules for Reactive Responders. This pattern indicates that transformational leaders invest in more thorough and systematic capacity building.

Third, stakeholder engagement mechanisms differ markedly across leadership types, with Collaborative Facilitators establishing average of 3.4 partnership arrangements with external organizations (universities, NGOs, technology providers) compared to 0.8 partnerships for Delegative Coordinators. This pattern reveals that certain leadership styles naturally facilitate broader ecosystem engagement essential for sustainable digital transformation. Fourth, leadership visibility during implementation shows strong association with participant motivation and learning outcomes, with qualitative data indicating that village heads who regularly participated in training sessions created normative expectations that "digital literacy is important for everyone," reducing resistance and increasing voluntary participation among initially reluctant officials and community members.

Interpretation

These findings illuminate how village leadership serves as the pivotal mechanism translating national Smart Village policies into local realities. The strong positive correlation between transformational leadership characteristics and program implementation quality ($r=0.76$, $p<0.001$) suggests that successful digital transformation at the village level is fundamentally a leadership phenomenon rather than merely a technological or infrastructural challenge. The data support the theoretical proposition that transformational leaders facilitate digital governance transformation through three interconnected mechanisms: (1) vision articulation, where leaders frame digital transformation as essential for village advancement and create

shared understanding of digital futures; (2) resource mobilization, where leaders leverage their political and social capital to secure funding, partnerships, and technical support; and (3) organizational culture change, where leaders model digital behaviors, normalize technology use, and reduce psychological barriers to digital adoption among government apparatus and citizens.

The differential outcomes between leadership types reveal that passive or delegative approaches are insufficient for achieving meaningful digital transformation in resource-constrained village contexts. Villages led by Visionary Initiators and Collaborative Facilitators achieved digital literacy program outcomes 1.6 to 1.8 times higher than those led by Delegative Coordinators or Reactive Responders, suggesting that active, engaged leadership is not merely beneficial but essential for overcoming the multiple barriers to digital adoption in rural settings, including limited infrastructure, low baseline digital competencies, cultural resistance to technological change, and competing resource priorities.

Mechanisms through which Digital Literacy Education Enhances Village Administrative Capacity and Smart Village Implementation

Data Presentation

The second objective investigated the mechanisms linking digital literacy education programs to enhanced village administrative capacity and smart village implementation outcomes. Longitudinal assessment of 45 villages measured changes in digital governance capacity using the Village Digital Governance Index (VDGI), a composite measure encompassing five dimensions: (1) administrative digitalization, (2) data management capabilities, (3) e-governance platform utilization, (4) digital service delivery, and (5) transparency mechanisms. Baseline assessments (T0, January 2023) showed villages averaging VDGI scores of 32.4/100 (SD=12.8), while follow-up assessments (T1, October 2024) demonstrated improvements to 58.7/100 (SD=15.3), representing an 81.2% average increase ($t=18.42$, $p<0.001$).

Disaggregated analysis by program implementation quality revealed differential improvement patterns. Villages with high-quality digital literacy programs (DEPES ≥ 4.0 , $n=18$) improved VDGI scores by average of 34.6 points (106.8% increase), medium-quality programs (DEPES 3.0-3.9, $n=17$) improved by 26.3 points (81.2% increase), and low-quality programs (DEPES < 3.0 , $n=10$) improved by only 18.7 points (57.7% increase). Analysis of variance confirmed statistically significant differences between these groups ($F(2,42)=23.67$, $p<0.001$, $\eta^2=0.53$).

Interview data with 67 stakeholders identified six specific mechanisms through which digital literacy programs enhanced administrative capacity. First, Technical Competency Development enabled village officials to confidently operate e-governance platforms. As one village secretary explained: "Before the literacy training, I was afraid to touch the computer for official tasks. Now I manage the entire village budget system digitally, and I can generate reports in minutes instead of days. The systematic training approach,

starting from basic operations and progressively building to complex administrative tasks, made digital tools accessible to those of us without prior computer experience." Second, Organizational Process Redesign involved systematic workflow improvements. A village head from Central Java described: "The digital literacy program wasn't just about learning software; it forced us to examine and improve our entire administrative processes. We identified redundancies, eliminated unnecessary paperwork, and created standardized digital procedures. Our permit processing time decreased from 14 days to 3 days because we fundamentally changed how we work, not just digitized the old inefficient processes." Third, Data-Driven Decision Making Capacity emerged as officials learned to collect and analyze governance data for evidence-based planning.

Table 2. Pre-Post Comparison of Village Administrative Capacity Indicators (N=45 villages)

Indicator	Baseline (T0) Mean±SD	Follow-up (T1) Mean±SD	Change (%)	Effect Size (d)	Sig.
Administrative Digitalization	28.4±11.2	61.3±13.7	+115.8%	2.64	p<0.001
Data Management Capability	31.7±13.5	59.8±14.2	+88.6%	2.03	p<0.001
E-Governance Platform Use	35.6±14.8	62.4±15.9	+75.3%	1.75	p<0.001
Digital Service Delivery	33.2±12.6	56.7±16.1	+70.8%	1.63	p<0.001
Transparency Mechanisms	32.8±13.1	53.2±14.8	+62.2%	1.45	p<0.001
Overall VDGI Score	32.4±12.8	58.7±15.3	+81.2%	1.86	p<0.001

Note: VDGI = Village Digital Governance Index; Scores range from 0-100; T0 = January 2023; T1 = October 2024.

Restatement

The evidence demonstrates that digital literacy education programs serve as powerful catalysts for comprehensive administrative transformation in village governments. Villages that implemented high-quality digital literacy programs experienced substantial improvements across all measured dimensions of digital governance capacity, with changes ranging from 62% to 116% increases over the 22-month study period. These improvements were not limited to technical skill acquisition but extended to fundamental changes in organizational processes, decision-making approaches, transparency practices, and citizen engagement mechanisms.

Description of Patterns

Four critical patterns characterize the relationship between digital literacy programs and administrative capacity enhancement. First, a clear

dosage-effect relationship exists, where program implementation quality and intensity directly correlate with magnitude of administrative improvements. Villages investing in comprehensive programs (40+ training hours, multi-module curricula, ongoing support) achieved capacity gains approximately 1.9 times larger than villages implementing minimal programs (15-20 hours, single-module, one-time training). Second, temporal sequencing patterns indicate that different capacity dimensions improve at different rates, with administrative digitalization showing rapid improvement (reaching 60% of maximum potential within 6 months) while sophisticated capabilities like data-driven decision-making develop more gradually (reaching 60% after 14-16 months). Third, spillover effects emerge consistently, where improvements in one capacity dimension catalyze enhancements in other areas, with significant positive correlations among all five VDGI dimensions (r range: 0.54 to 0.78, all $p < 0.01$). Fourth, qualitative data reveal psychological transformation accompanying technical skill development, with officials reporting increased professional confidence and enhanced organizational identity as "modern" institutions, creating self-reinforcing cycles of continuous improvement.

Interpretation

These findings provide robust empirical evidence that digital literacy education functions as a comprehensive organizational intervention rather than merely a technical training program. The substantial effect sizes observed (Cohen's d ranging from 1.45 to 2.64) indicate that digital literacy interventions produce large, practically significant improvements in village administrative capacity, with changes of sufficient magnitude to fundamentally alter how village governments function. The 81.2% average increase in overall digital governance capacity represents a qualitative shift from minimal digital integration to moderate-to-advanced digital governance maturity, crossing critical thresholds that enable villages to effectively implement Smart Village initiatives. The multiple mechanisms identified technical competency, process redesign, data capabilities, knowledge networks, transparency enhancement, and citizen engagement expansion operate synergistically to transform village governance systems from analog, hierarchical, and closed structures toward digital, networked, and participatory models.

Leadership Competencies and Strategies Driving Effective Digital Transformation

Data Presentation

The third objective identified specific leadership competencies and strategies that effectively drive digital transformation at the village level. Competency assessment employed the Digital Leadership Competency Framework (DLCF), measuring 24 competencies across six domains. Quantitative analysis identified eight competencies most strongly associated with successful digital transformation outcomes: (1) Vision Articulation

($\beta=0.67$, $p<0.001$), (2) Stakeholder Mobilization ($\beta=0.61$, $p<0.001$), (3) Resource Acquisition ($\beta=0.58$, $p<0.001$), (4) Cultural Sensitivity ($\beta=0.54$, $p<0.001$), (5) Adaptive Planning ($\beta=0.52$, $p<0.01$), (6) Personal Digital Modeling ($\beta=0.49$, $p<0.01$), (7) Conflict Resolution ($\beta=0.46$, $p<0.01$), and (8) Continuous Learning Orientation ($\beta=0.43$, $p<0.05$). Multiple regression analysis revealed that these eight competencies collectively explained 72% of variance in digital transformation success ($R^2=0.72$, $F(8,36)=11.54$, $p<0.001$).

Qualitative investigation identified seven strategic approaches employed by successful digital transformation leaders: (1) Incremental Implementation, where leaders progressively introduced digital systems starting with simple, high-visibility applications; (2) Champions Network Development, where leaders identified and cultivated digital champions among staff and community; (3) Contextualized Curriculum Adaptation, where leaders customized training content to address specific village contexts; (4) Intergenerational Bridging, where leaders created mentoring relationships between digitally skilled younger staff and experienced older officials; (5) Visible Infrastructure Investment, where leaders prioritized tangible improvements demonstrating commitment; (6) Celebration and Recognition Systems, where leaders established mechanisms to recognize achievements; and (7) External Partnership Cultivation, where leaders proactively developed relationships with universities, technology companies, and NGOs.

Table 3. Comparison of Leadership Competencies and Strategies Between High and Low Performing Villages

Dimension	High-Performing (n=12) Mean±SD	Low-Performing (n=10) Mean±SD	Difference	Effect Size (d)
Digital Leadership Competency	4.28±0.31	2.87±0.44	+1.41	3.67
Vision Articulation Score	4.56±0.28	2.94±0.51	+1.62	3.89
Stakeholder Mobilization	4.41±0.33	2.73±0.48	+1.68	4.01
Strategic Approaches Used	5.8±1.2	2.1±0.9	+3.7	3.43
Personal Engagement (hrs/wk)	8.7±1.9	1.4±0.7	+7.3	4.89
External Partnerships	3.4±1.1	0.8±0.6	+2.6	2.92
Digital Champions Developed	4.2±1.3	1.1±0.8	+3.1	2.84
Community Engagement Rate	67.3±8.7%	31.2±11.4%	+36.1%	3.57

Note: All differences significant at $p<0.001$.

Restatement

The findings reveal that effective digital transformation leadership in village contexts requires a specific constellation of competencies and deployment of strategic approaches tailored to rural Indonesian realities. Successful village heads possess and actively demonstrate competencies in vision articulation, stakeholder mobilization, resource acquisition, and cultural sensitivity, combined with systematic implementation of strategies including incremental rollout, champions network development, curriculum contextualization, intergenerational bridging, infrastructure investment, recognition systems, and external partnership cultivation. The data show substantial differences between high-performing and low-performing villages across virtually all measured leadership dimensions.

Description of Patterns

Three overarching patterns characterize effective digital transformation leadership. First, successful leaders demonstrate integrated competency profiles rather than isolated skills, with high-performing village heads scoring consistently high across multiple competency domains, suggesting that effective digital leadership requires holistic capability. Second, strategic approaches employed by successful leaders share a common characteristic of addressing both technical and social-cultural dimensions of change, with each of the seven identified strategies explicitly acknowledging that digital transformation involves fundamental changes in organizational culture, social relationships, power dynamics, and collective identities. Third, successful leaders exhibit high levels of personal engagement and modeling behaviors, with high-performing village heads personally investing 8.7 hours weekly in digital activities compared to 1.4 hours for low-performers, revealing that transformational leadership requires substantial personal investment and visible commitment.

Interpretation

These findings advance understanding of leadership in digital transformation contexts by demonstrating that rural digital governance change requires distinctive leadership competencies substantially different from either traditional village governance or urban digital transformation. The eight critical competencies operate through specific mechanisms: vision articulation provides direction and meaning, stakeholder mobilization creates change coalitions, resource acquisition addresses fundamental constraints, cultural sensitivity prevents backlash, adaptive planning enables navigation of implementation challenges, personal digital modeling legitimizes technology use, conflict resolution addresses change tensions, and continuous learning orientation ensures sustained capability. The seven strategic approaches represent practical manifestations of these competencies, translating abstract leadership capabilities into concrete actions that simultaneously address technical, social, cultural, and political dimensions of organizational change.

The substantial differences observed between high and low-performing villages across leadership dimensions (effect sizes ranging from 2.84 to 4.89) indicate that leadership quality serves as a critical differentiating factor in digital transformation outcomes. These large effects suggest that investing in village leadership development may generate greater returns than investments in technology infrastructure alone. The contextual variations observed where effective leaders adapted strategies to specific village circumstances regarding infrastructure, demographics, and prior experiences demonstrate sophisticated situational leadership and challenge one-size-fits-all approaches to rural digital development.

Discussion

Summary of Research Findings

This research investigated the transformational role of village leadership in facilitating digital governance transformation through strategic implementation of digital literacy education programs within Indonesia's Smart Village framework. The empirical investigation across 45 villages over a 22-month period produced three principal findings that advance understanding of digital transformation in rural governance contexts. First, the study established that village leadership characteristics significantly influence digital literacy program implementation effectiveness, with transformational leadership approaches particularly Visionary Initiators and Collaborative Facilitators achieving program participation rates 35-52% higher and completion rates 31-61% higher than delegative or reactive leadership approaches. The quantitative evidence demonstrated a strong positive correlation ($r=0.76$, $p<0.001$) between transformational leadership scores and program quality metrics, indicating that approximately 58% of variance in program effectiveness can be attributed to leadership characteristics and behaviors.

Second, the research identified and empirically validated six interconnected mechanisms through which digital literacy education programs catalyze comprehensive administrative transformation: technical competency development, organizational process redesign, data-driven decision-making capacity, inter-village knowledge exchange, enhanced transparency and accountability, and expanded citizen engagement. Longitudinal assessment revealed substantial improvements across all measured dimensions of digital governance capacity, with the overall Village Digital Governance Index increasing by 81.2% from baseline to follow-up (32.4 to 58.7 on a 100-point scale). The magnitude of these improvements, reflected in large effect sizes (Cohen's d ranging from 1.45 to 2.64), represents qualitative shifts in how village governments function, moving from primarily analog, hierarchical, and closed systems toward digital, networked, and participatory governance models. Notably, the research documented significant dosage-effect relationships, with high-quality comprehensive programs producing improvements nearly twice as large as minimal

interventions, underscoring the critical importance of program design quality and implementation intensity.

Third, the investigation identified eight critical leadership competencies and seven strategic approaches that effectively drive digital transformation in Indonesian village contexts. The competency analysis revealed that vision articulation ($\beta=0.67$), stakeholder mobilization ($\beta=0.61$), and resource acquisition ($\beta=0.58$) emerged as the most powerful predictors of transformation success, collectively explaining 72% of variance in outcomes when combined with five additional competencies: cultural sensitivity, adaptive planning, personal digital modeling, conflict resolution, and continuous learning orientation. The strategic approaches documented incremental implementation, champions network development, contextualized curriculum adaptation, intergenerational bridging, visible infrastructure investment, celebration and recognition systems, and external partnership cultivation represent practical manifestations of these competencies. Comparative analysis between high-performing and low-performing villages revealed striking differences across all measured leadership dimensions, with effect sizes ranging from 2.84 to 4.89, indicating that leadership quality serves as a critical differentiating factor determining digital transformation success or failure.

Understanding the Causal Mechanisms of Leadership-Driven Digital Transformation

This research reveals that successful digital transformation in village governance is a socio-technical process mediated by leadership, rather than just a technological or administrative intervention. Strong leadership is found to be closely associated with transformation outcomes through three interconnected theoretical mechanisms: transformational influence, organizational learning facilitation, and institutional legitimization. First, transformational influence operates through leaders' ability to articulate compelling digital visions that appeal to both the rational interests and emotional commitments of village officials and the community. The data show that leaders who personally championed digital transformation and invested time in program design achieved higher outcomes, not because of superior technical expertise, but because they successfully framed digitalization as essential for village progress, competitive positioning, and institutional modernization.

Second, organizational learning facilitation explains why digital literacy programs lead to widespread improvements beyond initial skill acquisition. Effective leaders systematically create learning environments with psychological safety, encouragement of experimentation, error tolerance, and a continuous improvement orientation, transforming organizational cultures into learning organizations that embrace innovation and adaptation. Third, institutional legitimization explains the importance of leadership visibility and personal digital modeling.

In hierarchical village contexts, leaders' behaviors carry significant symbolic weight in defining what is considered legitimate and appropriate. The involvement of village heads in digital learning and their use of technology in leadership practice signals that digital competencies are essential qualifications for modern governance. Comprehensive digital literacy programs, with extended training and ongoing support, produce significantly greater improvements compared to minimal interventions, as they allow for deeper skill development and the integration of digital practices into organizational routines, driving sustainable transformation.

Comparison with Previous Research

The findings of this research both converge with and diverge from existing literature on digital governance, smart villages, and rural transformation. Regarding convergence, the documented importance of leadership commitment aligns with previous studies by [Mergel et al. \(2019\)](#) and [Dwivedi et al. \(2017\)](#), who identified leadership as a critical success factor in e-government implementation. However, this research extends beyond their primarily urban and national-level analyses by demonstrating specific mechanisms through which village-level leadership operates in resource-constrained rural contexts.

While [Mergel et al. \(2019\)](#) emphasized leaders' roles in driving digital innovation generally, this study provides granular evidence of how transformational leadership qualities vision articulation, stakeholder mobilization, resource acquisition, and cultural sensitivity specifically translate into program implementation effectiveness and administrative capacity improvements in grassroots governance settings. The strong predictive relationships identified (β coefficients ranging from 0.43 to 0.67) provide quantitative validation of theoretical propositions that previous studies articulated conceptually but rarely tested empirically in village contexts.

The research findings regarding digital literacy's comprehensive organizational impacts partially align with but substantially extend [Mergel et al. \(2019\)](#) and analyses of digital skills and social inequality. While these scholars convincingly documented digital literacy's importance for individual participation and opportunity access, they primarily conceptualized digital skills as individual competencies with social consequences. This research demonstrates that in organizational contexts specifically village governance digital literacy education functions as a comprehensive organizational intervention catalyzing systemic transformation across multiple dimensions simultaneously.

The six mechanisms identified (technical competency, process redesign, data capabilities, knowledge networks, transparency, citizen engagement) reveal interconnected organizational-level changes that cannot be reduced to aggregated individual skill improvements. This finding suggests that previous literature's individualistic framing of digital literacy may underestimate its transformative potential when deployed as a strategic organizational

development intervention, particularly in institutional contexts where digital adoption faces collective rather than merely individual barriers.

Regarding smart village implementation, this research both confirms and challenges perspectives in existing literature. Villages with strong leadership but limited infrastructure achieved better smart village outcomes than villages with adequate infrastructure but weak leadership, contradicting infrastructure-deterministic perspectives prevalent in much smart city and smart village literature. This finding resonates more closely with [Naldi et al. \(2015\)](#) recognition of smart rural development's multidimensional nature but provides empirical specificity their conceptual framework lacked regarding the precise role of local leadership and capacity building.

A significant divergence from previous research emerges in this study's documentation of context-specific strategic approaches village leaders employed. Much existing digital governance literature, exemplified by [Gil-Garcia et al. \(2018\)](#) and [Khan et al. \(2014\)](#) emphasizes universal best practices, standardized implementation frameworks, and technology-driven solutions applicable across diverse contexts. This research reveals that successful digital transformation in Indonesian villages required sophisticated contextual adaptation leaders adjusting strategies based on specific infrastructure conditions, demographic compositions, cultural values, and prior experiences.

The seven strategic approaches identified (incremental implementation, champions networks, curriculum contextualization, intergenerational bridging, infrastructure investment, recognition systems, external partnerships) represent situated practices responding to Indonesian rural realities rather than universal prescriptions. This finding challenges the assumption underlying many e-government frameworks that successful digital transformation follows standardized pathways, suggesting instead that effective implementation requires flexible, adaptive strategies sensitive to local socio-cultural, economic, and institutional contexts.

Broader Implications for Digital Governance Theory and Practice

The research highlights significant theoretical, methodological, and practical insights into digital transformation in rural governance, proposing a leadership-mediated socio-technical perspective that challenges both technological and organizational determinism. It emphasizes that successful digital transformation arises from the interplay between technology, organizational systems, human capacities, and leadership practices, which orchestrate these elements into effective change processes.

The study also reveals the critical political and cultural dynamics that shape successful implementation, including the negotiation of power relations, generational tensions, and cultural values. From a social justice perspective, it shows the potential of digital platforms to enhance citizen engagement and transparency, but also highlights risks such as digital exclusion, particularly for marginalized groups. Additionally, the research underscores the temporal dimensions of digital transformation, noting that its progression occurs in

stages and requires sustained, longitudinal support for success, rather than short-term interventions.

Functions and Dysfunctions of Digital Village Governance Transformation

The research on leadership-driven digital transformation in village governance highlights both positive outcomes and potential challenges. Manifest functions include significant improvements in administrative efficiency, service delivery, transparency, and participatory governance, aligning with Smart Village policy objectives. Latent positive effects include enhanced professional identity among village officials, fostering intergenerational mentoring, and creating enduring external partnerships that support broader village development.

However, potential dysfunctions also emerged, such as a technocratic bias that marginalizes non-digitizable functions, increasing dependency on external technical support, and reinforcing hierarchical governance structures that could undermine sustainability after leadership transitions. Additionally, while digital literacy programs improved officials' capabilities, they inadvertently created inequalities, excluding vulnerable community members, such as the elderly or those in remote areas, from the benefits of digital governance. These issues suggest a need for a more balanced, inclusive approach to ensure the long-term success and equity of digital transformation efforts.

Policy Implications and Action Recommendations

Based on the research findings and their interpretations, this study offers seven strategic policy recommendations for government agencies, development practitioners, and village communities seeking to advance digital transformation in rural governance contexts.

1. **Village Leadership Development:** National and provincial governments should focus on developing village leadership with digital transformation competencies through training programs based on experiential learning, involving visits to successful digital villages and peer mentoring.
2. **Sustained Digital Literacy Learning Model:** Digital literacy programs should follow a phased approach: (1) Foundation Phase (6-8 months), (2) Development Phase (10-12 months), and (3) Advancement Phase (ongoing), with long-term funding (at least 3 years) and evaluation based on each phase's maturity.
3. **National Digital Village Excellence Network (NDVEN):** The government should establish a platform for knowledge exchange among villages, supported by peer mentoring and the dissemination of best practices through annual conferences, virtual exchanges, and village-to-village partnerships.
4. **Contextualized Digital Literacy Curriculum:** The digital literacy curriculum must be tailored to local contexts, including the village's economic activities, demographics, and cultural values, with active involvement from village leaders and communities in designing training materials.

5. Equity in Smart Village Initiatives: Policies should include measures to ensure digital transformation promotes inclusion, such as ensuring accessibility for people with disabilities, providing analog service alternatives, and conducting regular equity audits to assess who benefits from digital governance.
6. Digital Sustainability Planning: Villages should develop Digital Governance Succession Plans to ensure the continuity of digital systems during leadership transitions, with documentation of digital processes, multi-level champion networks, and community oversight.
7. Continuous Research and Evaluation: A Digital Transformation Research Institute should be established to document and analyze best practices, provide national dashboards to track smart village progress, and support evidence-based policy-making through regular publication of research findings.

The implementation of these recommendations requires collaboration across national, provincial, district, and village levels, as well as other stakeholders, to ensure an inclusive, sustainable, and effective digital transformation.

CONCLUSION

This study explored the transformational role of village leadership in driving digital governance within Indonesia's Smart Village initiative, focusing on the impact of digital literacy programs across 45 villages over 22 months. The research identified key solutions to challenges such as inadequate digital transformation, low digital literacy, and persistent digital divides by emphasizing the importance of leadership development and comprehensive, contextualized digital literacy education. Key findings revealed that transformational leadership directly influences the success of digital initiatives, while high-quality, multi-stage training programs produce significant improvements in governance capacity.

The study contributes to the theory of leadership-mediated socio-technical digital transformation and calls for a shift in policy focus towards leadership development, alongside infrastructure, to drive sustainable digital governance in rural areas. Recommendations include targeted investments in leadership training, curriculum adaptation, and long-term support for village governments, as well as strategies for reducing digital exclusion. The research also highlights limitations, including the geographical scope and measurement constraints, which may affect generalizability and underscore the need for further research to explore long-term sustainability, equity, and inclusion in digital governance.

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