



Digital adaptive governance and school safety: informatization for post-flood educational continuity in Aceh Barat Daya

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ABSTRACT

Recurrent flooding in Aceh Barat Daya severely disrupts school operations, threatens physical safety, interrupts learning access, and erodes community well-being. Existing research presents three key gaps: empirically, studies focus largely on infrastructure repair or traditional preparedness and rarely examine informatization as a governance capability; theoretically, models separate digital systems from adaptive leadership rather than integrating them; methodologically, accounts remain mostly descriptive without cross-case analysis of adoption processes. This qualitative multiple-case study investigates how three flood-prone public schools integrate digital systems, shared information platforms, and collaborative management to strengthen safety assurance, adaptive decision-making, and learning continuity. Data from interviews, documents, and observations were analysed using thematic analysis. Key findings identify four interconnected dimensions: digital early warning and coordination, data-driven governance, informatization-enabled hybrid continuity, and collective safety management. As a novelty, the study proposes the Digital Adaptive Educational Safety Framework, which unites these components while aligning technology with local cultural practices—shifting response from reactive to proactive. The findings advance understanding of how information systems build educational resilience, relevant for disaster-prone regions globally.

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1. INTRODUCTION

Globally, educational institutions increasingly operate amid environmental uncertainty, where climate-related hazards routinely disrupt routine management and service delivery. Beyond maintaining instructional quality, schools now bear expanded responsibility for educational safety—including physical protection, uninterrupted learning access, and psychosocial well-being—while responding to recurring crises. In this evolving landscape, educational administration has shifted from hierarchical, compliance-focused models toward adaptive governance, which prioritizes timely information, collaborative decision-making, and flexible resource allocation (Hallinger et

al., 2015). While other experts identify informatization as a critical driver of this transition, noting that integrating digital systems, data management, and communication platforms improves efficiency and supports evidence-based action, existing studies largely frame informatization as a technical upgrade rather than a foundational component of governance itself, rarely examining how digital tools become embedded in day-to-day decision-making or institutional culture. (Uhl-Bien & Arena, 2018).

Indonesia ranks among the world's most disaster-prone nations; in 2024 alone, climate hazards disrupted education for approximately 242 million students across 85 countries, with floods cited as one of the most damaging causes of prolonged school closures (UNICE, 2025). This pattern is clearly visible in Aceh: late 2025 seasonal flooding damaged or submerged more than 310 education units, with Aceh Barat Daya experiencing repeated disruptions that halted learning for weeks or months. For local schools, floods are no longer exceptional events but recurring organizational challenges that demand continuous adaptation to safety protocols and service delivery. Although many also observe that many schools still depend on verbal alerts, manual checklists, and delayed reporting—practices that slow response times, raise risk levels, and deepen inequities in access—prior research on disaster education in Aceh has largely examined physical preparedness, infrastructure resilience, and traditional leadership structures separately, treating safety management and information use as unrelated domains rather than interconnected governance functions (Harris & Jones, 2020).

Existing scholarship reveals two critical limitations that this study seeks to address. First, research on disaster risk reduction in Aceh focuses disproportionately on physical infrastructure and emergency drills, with almost no attention to how information systems shape adaptive decision-making or long-term post-disaster recovery. Second, studies of digital disaster management tend to prioritize the functionality of technical tools over how these systems are actually adopted, adapted, and used by school leaders, communities, and local authorities—especially in contexts with limited infrastructure but strong established community cooperation (Hallinger et al., 2015).

No prior empirical work has explicitly linked informatization to adaptive governance in flood-prone school settings in Aceh Barat Daya, nor explored how digital systems can simultaneously strengthen immediate safety responses and sustain educational continuity over time. This gap leaves a major blind spot in understanding how information technology can operate as a core governance capability rather than an optional auxiliary add-on, particularly in regions where formal resources are constrained but social solidarity is robust (Gash, Collaborative governance in theory and practice, 2008). To address these gaps, this study answers two core research questions: (a) How do schools integrate informatization into adaptive governance to ensure safety during and after flood events in Aceh Barat Daya? (b) What role do digital systems play in sustaining learning continuity and strengthening institutional resilience in flood-prone settings?

Drawing on adaptive leadership theory (Heifetz et al., 2009), collaborative governance (Ansell & Gash, 2008), and educational informatization frameworks (UNESCO, 2021), this study develops a context-specific conceptual model tailored to Aceh's conditions, centering digital safety and information management. The findings provide empirical evidence aligned with *Jurnal Mantik's* scope on information systems, management science, and applied technology, while extending current knowledge of how digital tools can build institutional resilience in disaster-prone educational environments (Berkes & Ross, 2016).

2. RESEARCH METHOD

2.1 Research Design

This study adopted an interpretivist qualitative paradigm combined with a multiple-case study design, chosen to explore how adaptive school leadership operates as a governance capability to sustain learning continuity and strengthen institutional

resilience under recurring flood conditions. An interpretivist approach was appropriate because adaptive leadership and educational governance are socially constructed through interactions, shared practices, and contextual experiences that cannot be fully captured through standardized measurements alone (Creswell & Poth, 2018). Instead of aiming for statistical generalization, this design prioritized in-depth understanding of processes within their natural settings, consistent with the study's focus on context-specific leadership and governance dynamics across different school levels.

A multiple-case study design was selected to examine similarities and variations across a broad set of institutions, enabling robust cross-case comparison and analytical replication (Yin, 2018). This approach allowed the researcher to identify consistent patterns of adaptive practice while preserving unique contextual responses across junior high, senior high, and madrasah levels. It was particularly suited to the research focus, as flood-related disruptions represent complex, context-bound phenomena requiring holistic examination of organizational, social, and cultural dimensions across diverse educational settings.

2.2 Research Sites and Participants

The research was conducted in 10 selected public educational institutions located in flood-prone subdistricts of Aceh Barat Daya Regency, Indonesia. Aceh Barat Daya provides an information-rich setting for this study because seasonal flooding has become a recurring environmental challenge that repeatedly interrupts educational activities across coastal, low-lying, and inland areas, requiring school leaders to continuously adapt administrative practices and instructional management. The 10 participating schools were selected using purposive criterion sampling based on four key considerations: (1) repeated annual exposure to seasonal flooding over the last five years; (2) direct experience managing educational disruptions and post-flood recovery processes; (3) representation across different education levels and geographic zones to capture diverse adaptive responses; and (4) willingness to participate throughout all stages of data collection. The selected institutions cover coastal floodplains (Blangpidie, Kuala Batee, Susoh) and inland low-lying areas (Manggeng, Tangan-Tangan, Babahrot), including both general and specialized educational units.

Participants included 32 key informants across all sites: ten school principals, seven vice principals, eight teachers, three school committee representatives, three village community leaders, and one district education official. Sampling prioritized information-rich participants directly involved in decision-making, safety coordination, or recovery planning before, during, and after flood events (Patton, 2015). Recruitment continued until data saturation was reached, with no new themes emerging from additional interviews.

2.3 Data Collection

Data were collected over four months using three complementary methods to achieve methodological triangulation (Creswell & Poth, 2018):

a. Semi-structured Interviews

The primary data source, using an open-ended guide to explore leadership decisions, stakeholder coordination, resource mobilization, and recovery strategies across different school levels and locations. Interviews allowed flexibility to follow emerging lines of inquiry while maintaining consistency across all 10 cases.

b. Sample Interview Questions

How do you adjust school management and decision-making when flood warnings are issued? What information systems or communication tools do you use to coordinate safety and learning continuity?. How do you collaborate with teachers, communities, and local agencies during and after floods?. What barriers or supports shape how you adapt

governance practices in repeated flood events? What changes have you made over time to improve preparedness and recovery?

c. Document Analysis

Reviewed institutional emergency plans, meeting minutes, safety protocols, damage assessment reports, and correspondence to verify interview accounts and trace decision-making processes.

d. Field Observations

Conducted non-participant observations of school facilities, temporary learning arrangements, community clean-up activities, and coordination meetings to capture practices that participants might not explicitly articulate.

All interviews were recorded with written permission, transcribed verbatim, and supplemented by detailed field notes and document summaries.

2.4 Data Analysis

Data were analyzed using three-stage coding: Open-Axial-Selective (Strauss & Corbin, 1998), supported by NVivo 12 software for systematic organization and retrieval, alongside manual cross-checking of all transcripts and field notes.

Coding Process: Open Coding: All transcripts, field notes, and documents were read line-by-line to label meaningful segments with descriptive codes. Axial Coding: Related codes were grouped into sub-themes based on conceptual links and relationships between categories. Selective Coding: Core themes were identified that connected all sub-themes and directly addressed the research objectives.

Table 1: Coding Tree Example:

Codes	Sub-themes	Main Themes
Verbal alerts, WhatsApp groups, manual logs	Information & Communication Practices	Informatization in Adaptive Governance
Shifting classes, temporary spaces, flexible timetables	Learning Continuity Arrangements	
Principal-teacher coordination, community-school meetings	Collaborative Decision-Making	
Damage reporting, resource sharing, routine updates	Flood Response & Recovery Processes	

Source: Author's Data Analysis, 2026

Data Saturation: Recruitment and interviewing stopped when no new codes, sub-themes, or properties of existing themes emerged from three consecutive additional interviews. Saturation was confirmed at the 32nd participant, with all subsequent data only repeating previously identified patterns. Cross-case analysis was then applied to distinguish shared patterns from context-specific responses across coastal/inland areas and school levels (Yin, 2018).

Table 2: Methodological Triangulation:

Main Theme	Interviews	Observations	Documents
Digital & manual communication	Participants report mixing WhatsApp, phone calls, and verbal announcements	Field notes confirm use of group chats and posted notices	Emergency plans list multiple communication channels
Flexible learning arrangements	Leaders describe shifting schedules or using alternate spaces	Observed temporary classrooms and adjusted timetables	Official circulars and attendance records confirm changes
Community involvement	Informants explain joint cleaning, donation, and monitoring	Observed mutual aid work and coordination	Signed agreements and committee minutes recorded

Afdhal Jihad, Digital adaptive governance and school safety: informatization for post-flood educational continuity in Aceh Barat Daya

Repeated adaptation	Participants state updating protocols after each flood	meetings Noted revised safety signs and updated layouts	Successive versions of disaster plans and damage reports
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Source: Author's Analysis of Interview, Observation, and Document Data, 2026

This table cross-verifies findings across interviews, observations, and documents. Consistent alignment confirms the reliability of key themes—communication, flexible arrangements, community involvement, and iterative adaptation—strengthening credibility through triangulation.

2.5 Trustworthiness and Ethical Considerations

Rigor follows Lincoln & Guba's criteria: credibility via triangulation and member checking; transferability through thick description; dependability via audit trails; confirmability through evidence-linked analysis (Katiman, 2021). Ethics include informed consent, anonymity, and right to withdraw.

3. RESULTS AND DISCUSSION

3.1 Digital Adaptive Governance in Practice

Findings show informatization functions as the core foundation of adaptive governance across all studied sites. It integrates digital tools, shared information systems, and coordinated decision-making to strengthen safety assurance, response speed, and learning continuity. This integrated process is detailed in the conceptual model and coding structure presented below, illustrating how technology and collaborative practice operate as one unified system.

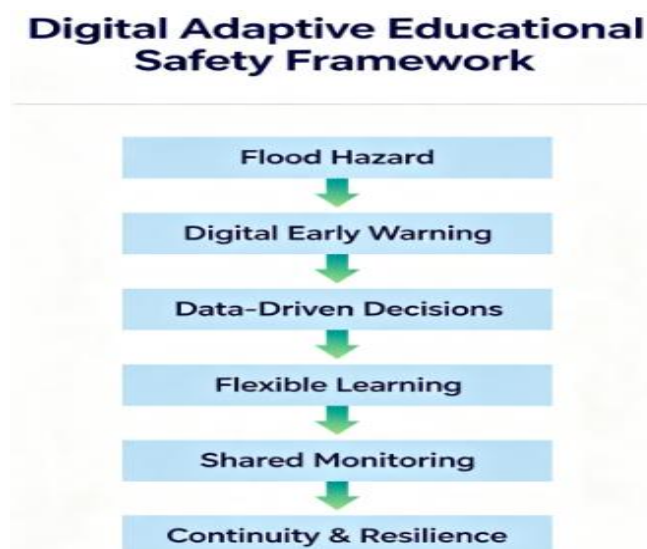


Figure 1. Conceptual Model of Digital Adaptive Educational Safety Framework

Systematic coding across all interviews, observations, and documents yielded four core themes and associated sub-themes that describe how informatization operates as an integrated governance capability. These categories capture the full sequence from early warning through decision-making, learning delivery, and collective oversight, as summarised below.

Table 1. Coding Structure

Main Theme	Sub-themes
Digital Early Warning & Coordination	• Multi-channel alerts • Real-time updates • Digital safety checks
Data-Driven Adaptive Governance	• Shared damage records • Attendance/location tracking • Schedule adjustments
Informatization for Learning Continuity	• Hybrid/home learning • Digital tasks & chats • Recorded materials
Collective Digital Safety Management	• Joint monitoring • Shared recovery logs • Transparent resource updates

Source: Research Data, 2026

These elements work as one connected system: alerts trigger sharing, verified data guide decisions, and digital tools sustain both safety and learning.

3.2 Key Findings from Data Analysis

Analysis of interview transcripts, field notes, and institutional documents across all ten schools yielded four robust themes derived through open-axial-selective coding, with consistent frequency of occurrence across cases: (1) Holistic Disruption and Welfare-First Prioritisation (30 coding references), (2) Distributed Collaborative Governance (27 references), (3) Adaptive Learning Arrangements (24 references), and (4) Collective Capacity and Institutional Resilience (29 references). These themes show how schools moved beyond physical damage response to holistic governance rooted in local context.

Flooding was not limited to buildings; it disrupted livelihoods, transport, and family stability. Participants consistently placed human welfare ahead of administrative routine: *“When floods come, our first concern is not classrooms but the safety of students and staff”* (Principal, SMP Negeri 1 Blangpidie). Teachers and students often suffered personal losses alongside institutional damage, requiring schools to address emotional and material needs before resuming instruction. This confirms that educational continuity depends on community well-being, not only facility repair (Yurkofsky & Peurach., (2023).

Second, decision-making shifted from waiting for top-down directives to distributed governance. Road closures and rapid water rise made delayed responses dangerous; instead, principals, teachers, keuchik, religious leaders, and committees decided jointly: *“We cannot wait for official letters every time roads are cut off... we use the meunasah so learning never stops”* (Leader, SMA Negeri 5). This pattern draws on Aceh’s traditions of meuseuraya and collective deliberation, turning hierarchy into partnership (Katiman, 2021).

Third, schools adapted delivery flexibly: relocating to higher ground, rotating attendance, using village halls, home visits, and adjusted schedules. Coastal and inland sites applied different but equally responsive measures, proving continuity requires organisational agility as much as teaching effort (Yukl, (2020) (Trinidad & Protacio-De Castr, 2020). Gaps remained: remote areas faced delayed aid, and low-income students lacked electricity or study space, reflecting broader socio-economic disparities (Zuckerman, 2024).

Fourth, collective action built lasting resilience. Communities cleaned, repaired, and prepared spaces before official aid arrived; schools updated plans, ran drills, and documented lessons from each event. *“We have faced difficulty many times—schools cannot work alone”* (Senior Teacher, MAN Inovasi). Repeated experience transformed

reactive crisis management into proactive adaptive governance, strengthening institutional capacity over time (Kusumasari & Alam, 2012).

3.3 Conceptual Model of Adaptive Governance

Analysis identifies seven interconnected stages forming the adaptive governance process. This sequence shows how responses evolve from initial hazard through collective action, linking safety, decision-making, and learning to build lasting institutional readiness, as detailed below.

Figure 1. Conceptual Model of Adaptive School Governance in Flood-Prone Contexts

Stage	Key Process	Core Outcome
1	Flood Hazard	Environmental disruption triggers response
2	Holistic Safety & Welfare	Prioritise people over facilities
3	Distributed Joint Decision-Making	Collective deliberation replaces hierarchy
4	Flexible Learning & Operations	Adapt delivery to changing conditions
5	Collective Community & Cross-Sector Support	Mobilise shared resources
6	Sustained Educational Continuity	Keep learning accessible safely
7	Long-Term Institutional Resilience	Turn experience into preparedness

Source: Research Data, 2026

Across all cases, adaptive governance emerges not as policy or individual skill, but as a dynamic, context-embedded process linking schools deeply with communities, culture, and shared experience. Analysis across all ten cases reveals consistent patterns defining adaptive governance, grounded in interviews, observations, and documents. Responses form interconnected practices: local collaboration replaces top-down rules, delivery adapts flexibly, community bonds strengthen capacity, and experience builds readiness. The table below summarises themes, patterns, evidence, and interpretation, showing adaptive leadership as a collective system rather than individual skill.

Table 3. Cross-Case Comparison of Practices

Theme	Pattern	Evidence	Interpretation
Leading through uncertainty	Collaborative local decisions	"We cannot wait for official orders"	Leadership = shared governance
Learning continuity	Flexible arrangements	"Learning continues elsewhere"	Adaptation sustains access
Collective capacity	Community & stakeholder support	"Everyone helps restore schools"	Social capital expands capacity
Learning recovery	Holistic well-being + academics	"Safety first, then lessons"	Care supports effective recovery
Institutional resilience	Learning from past experience	"More prepared each time"	Experience builds long-term readiness

Source: Authors' thematic analysis of data.

Table 3 summarizes the five overarching themes identified through the thematic analysis. The findings demonstrate that adaptive leadership during disasters extends beyond administrative decision-making to encompass collaborative governance, flexible learning arrangements, community engagement, student well-being, and organizational learning. Collectively, these interconnected themes illustrate how adaptive leadership strengthens institutional resilience and supports educational continuity in disaster-prone contexts.

3.4 Discussion

a. Adaptive Leadership as Governance, Not Individual Competence

Adaptive leadership operates as collective governance, not individual authority (Hallinger et al., 2015). Distributed across teachers, keuchik, and communities via meunasah and meuseuraya, it challenges leader-centric models (Yukl, (2020). Similar patterns appear in the Philippines and Nepal, yet this study shows Aceh's traditions are functional governance mechanisms, not just context—extending distributed leadership theory (Trinidad & Protacio-De Castr, 2020).

b. Collaborative Governance and Social Capital

Community-led action outpaces bureaucratic delay (Berkes & Ross, 2016). Aligning with findings from Indonesia and Bangladesh, pre-existing trust becomes operational strength (Lassa et al., 2023). Unlike frameworks separating schools from communities, this work shows social capital expands institutional capacity, refining collaborative governance theory for settings with strong cohesion but limited infrastructure.

c. Sustaining Continuity amid Uneven Recovery

Flexible arrangements sustain access but reveal persistent gaps—continuity does not equal equity. Prioritising welfare first confirms that material and psychological stability are prerequisites for learning, challenging models treating well-being and academics as sequential rather than interdependent (Hallinger et al., 2015).

d. Theoretical Contributions

The proposed Adaptive Educational Governance framework unites collective sense-making, distributed coordination, cultural capital, and iterative learning. It bridges educational leadership, disaster management, and social capital theory, showing how local systems strengthen formal structures—offering transferable insights for hazard-prone regions globally

Table 4. Summary of Discussion and Theoretical Alignment

Core Finding	Theoretical Basis	Key Literature	Implication
Shared, not individual leadership	Distributed Adaptive Governance	Heifetz et al. (2009); Harris & Jones (2020)	Build relational systems; embed local leaders
Collaboration replaces hierarchy	Collaborative Governance & Social Capital	Berkes & Ross (2016); Ansell & Gash (2008)	Formalise partnerships; value culture as capacity
Safety before academics	Holistic Resilience	Hallinger et al. (2015); Gutman (2024)	Integrate welfare; target equity gaps
Culture strengthens systems	Context-Responsive Governance	Uhl-Bien & Arena (2018); Katiman (2021)	Avoid one-size-fits-all; align policy locally

Source: Authors' synthesis of findings and literature, 2026

5. CONCLUSION

This study finds adaptive leadership is collaborative governance, not individual skill—rooted in meunasah, meuseuraya, and keuchik practices. Responses have shifted from reactive to proactive, though equity gaps remain. The proposed Adaptive Educational Governance framework frames resilience as relational and cultural, not merely technical.

Contributions & Implications, Academic: Advances adaptive governance and educational informatization theory by integrating indigenous social capital into formal risk-response models. **Managerial:** Guide principals to prioritise local partnership over waiting for directives; combine digital and trusted traditional communication channels.

Policy: Recommend authorities formalise multi-stakeholder coordination, allocate targeted support to vulnerable areas, and recognise cultural practices in official

guidelines. Practical: Schools can form standing community teams, pre-approve flexible learning arrangements, and systematically record lessons from each event. Limitations: Data come from flood-prone Aceh Barat Daya public schools; findings may not apply to other hazards or regions with different social structures. Future Research: Test this framework across other districts and disaster types; examine how digital systems further strengthen community-led governance.

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