International Journal of Safety and Security Engineering
Vol. 15, No. 12, December, 2025, pp. 2541-2549
Journal homepage: http://iieta.org/journals/ijsse

A Hybrid Model of Disaster-Resilient Schools in Padang City, Indonesia

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https://doi.org/10.18280/ijsse.151211

Received: 13 October 2025
Revised: 13 December 2025
Accepted: 22 December 2025
Available online: 31 December 2025

Keywords:
school resilience, disaster risk, risk management, hybrid model, local wisdom, Padang City

ABSTRACT

Padang City is highly vulnerable to earthquakes and tsunamis, making it an important context for examining the role of schools in building disaster awareness and resilience. Although the Disaster-Safe Education Unit (Satuan Pendidikan Aman Bencana – SPAB) has been promoted nationally, its local implementation remains largely ceremonial and weakly integrated into school governance and learning processes. This study aims to develop a hybrid model of disaster-resilient schools that is responsive to the social, institutional, and cultural. This research adopts a qualitative case study approach. Data were collected through in-depth interviews with stakeholders from the Padang City Disaster Management Agency (BPBD), the Education Office, civil society organizations, Disaster Preparedness Groups (Kelompok Siaga Bencana – KSB), and two pilot schools. Field observations and document analysis complemented the interviews. Data were analyzed using thematic analysis. The findings reveal four main barriers to disaster education institutionalization: limited budget allocation, low teacher capacity, weak monitoring and evaluation, and the absence of local regulations on SPAB. Enabling factors include inter-institutional partnerships, civil society engagement, strong school leadership, and the integration of local wisdom and collective disaster memory. Based on these findings, the study proposes a hybrid model of disaster-resilient schools emphasizing adaptive institutions, community participation, and the integration of local knowledge and technology.

1. INTRODUCTION

Padang City is one of the areas with the highest levels of vulnerability to earthquakes and tsunamis in Indonesia [1]. Geographically, this region is located within an active subduction zone, placing it along the "Ring of Fire," with a long history of major disasters that have repeatedly caused loss of life and extensive infrastructure damage [2]. In this context, schools occupy a paradoxical position: on the one hand, they are highly vulnerable to disaster impacts; on the other, they possess strategic potential as spaces for cultivating a culture of disaster awareness from an early age. The central question that emerges, therefore, is to what extent schools in Padang City have genuinely shifted from being merely objects of risk to becoming active subjects in disaster resilience governance.

Normative efforts to position education as a primary channel for mainstreaming disaster-resilient schools have, in fact, been initiated through various national regulations, one of which is the Circular Letter of the Minister of National Education No. 70a/MPN/SE/2010 on the Mainstreaming of Disaster Risk Reduction in Education [3]. At the local level, the Disaster-Safe Education Unit (Satuan Pendidikan Aman Bencana – SPAB) program has been introduced as an operational framework for schools to build institutional preparedness [4]. However, field findings indicate that many disaster education practices in Padang City remain at a ceremonial level, such as annual simulations without follow-up, contingency plan documents prepared primarily for administrative purposes, and socialization activities that are not integrated into either the curriculum or school culture. This gap between formal regulation and actual practice signifies that the transformation toward disaster-resilient schools has not yet been fully institutionalized.

Beyond policy implementation issues, the vulnerability of schools in Padang City is also reinforced by structural and spatial factors. Many educational institutions are located in densely populated areas close to coastal zones, exposing them directly to tsunami threats [5]. Building conditions that do not

fully meet disaster-resilient standards, limited evacuation routes, and inadequate safety-supporting facilities further underscore that the physical dimension of school resilience has not been sufficiently addressed [6]. At the same time, disparities persist in the knowledge and awareness of school communities regarding self-rescue procedures, risk mapping, and evacuation mechanisms, resulting in a mismatch between high disaster potential and limited response capacity.

Conversely, both theoretical and empirical studies recognize schools as strategic agents of social change [7]. Schools function not only as spaces for knowledge transmission but also as arenas for the formation of character, values, and collective practices [8]. Disaster education that is systematically integrated into learning processes, school regulations, and everyday culture has the potential to shape a generation that understands risk, can act swiftly in crisis situations, and disseminates preparedness values to families and surrounding communities [9]. However, for such a transformation to occur, schools cannot operate in isolation; they require consistent policy support, institutional strengthening, and community networks, rather than merely temporary directives.

Another prominent challenge is the weak institutional synergy among key local actors. The Padang City Disaster Management Agency (BPBD) does serve as the main node in SPAB implementation; however, budget constraints and limited human resources mean that many programs operate largely on the basis of "idealism" rather than robust institutional design. The Education Office, Environmental Agency, Public Works and Spatial Planning Agency (PUPR), and other local government units hold relevant mandates, yet their contributions are often fragmented and not organized within a sustainable collaborative framework. As a result, schools frequently find themselves at a crossroads, becoming objects of various project-based activities without clear long-term mentoring mechanisms or integrated performance benchmarks.

From a socio-cultural perspective, Padang City and Minangkabau society possess rich social capital for building community-based resilience [10]. The collective memory of the 2009 major earthquake, traditions of mutual cooperation (gotong royong), and the presence of cultural symbols such as tabuah constitute cultural resources that can be mobilized to strengthen preparedness. Independent evacuation practices that have emerged within certain coastal communities demonstrate that society is capable of developing adaptive mechanisms outside the formal state framework [11]. The key challenge, therefore, lies in how to connect these cultural strengths with the formal education system in schools, so that resilience is not merely spontaneous and situational, but is constructed as part of a reflective and sustainable learning system.

From a scholarly standpoint, studies on disaster-safe schools in Indonesia tend to focus primarily on technical infrastructure aspects, physical risk assessments, or descriptive program evaluations [12]. Relatively few studies examine in depth how local institutional configurations, the roles of civil society organizations, and local wisdom interact within the practice of disaster education in schools. Moreover, the dynamics of Padang City as a "living laboratory" for earthquakes and tsunamis provide a critical opportunity to explore how schools can function as nodes that bridge formal state policies and community-based resilience. It is this gap that the present study seeks to address.

However, these studies generally stop at mapping levels of preparedness or assessing program effectiveness, without sufficiently explaining how inter-actor interactions, institutional mechanisms, and socio-cultural practices collectively shape school resilience in a systemic manner. In other words, there remains a limited understanding of how local institutional configurations, the role of civil society organizations as policy drivers, and the integration of local wisdom can be assembled into a coherent framework of adaptive and sustainable disaster education governance.

Building on this gap, the present study explicitly moves beyond descriptive evaluation by developing a conceptual model that elucidates the processes, relationships, and actor roles involved in constructing disaster-resilient schools. The proposed hybrid model does not merely assess "what works" or "what does not," but rather explains "how" and "why" school resilience emerges through the interaction of formal policies, institutional capacities, community participation, and local wisdom-based practices.

This study aims to formulate a hybrid model of disaster-resilient schools that is relevant to the social, institutional, and cultural contexts of Padang City. Specifically, the study seeks to: analyze patterns of institutional coordination and the roles of cross-sector actors in the implementation of disaster education in schools; identify best practices and key barriers in the implementation of SPAB in Padang City schools, with a focus on SMAN 1 and SMPN 25 as case studies; and develop a conceptual model of disaster-resilient schools that integrates adaptive institutional dimensions, human resource capacity, community participation and incorporation of local wisdom and technology.

Academically, this study contributes to the development of the literature on education-based disaster governance, particularly through a hybrid governance perspective that integrates state actors, civil society, and local communities. Practically, the proposed model is expected to serve as a reference for local governments, schools, and civil society organizations in designing disaster education interventions that go beyond ceremonial activities and are truly embedded within school systems and cultures. In this way, the study seeks to promote a shift from a "program-based" logic to a "systems-based" logic in positioning schools as pillars of disaster resilience in Padang City and other disaster-prone regions of Indonesia.

2. LITERATURE STUDY

Research on disaster risk reduction (DRR) within educational settings underscores the potential of schools as critical institutions for building resilience, but also highlights persistent challenges in institutionalization, curriculum integration, and sustainability. A global systematic review of school-based DRR shows that DRR implementation in schools, especially in disaster-prone regions, is essential to establish a resilient education system capable of withstanding future disasters [13]. Meanwhile, other studies affirm that disaster-resilient schools are more than safe infrastructures; they involve risk-reducing strategies that enable schools to respond and recover effectively when disasters occur [14].

One strand of literature emphasizes the integration of DRR into school curricula and routines. For example, DRR integration into school curriculum: A global analysis argues that for DRR to be effective and sustainable, it needs to be

embedded into formal curricula, school policies, and everyday learning, not limited to ad-hoc activities or extra-curricular drills [15]. Similarly, context-specific studies such as Key elements of disaster mitigation education in inclusive school settings find that integrating DRR content into regular subjects and inclusive settings can improve students' awareness and preparedness across various demographic groups.

However, embedding DRR education faces structural and practical constraints. For Indonesia, disaster risk reduction education (DRRE) in Indonesia: challenges and recommendations for scaling up identifies seven major issues impeding the scaling up and sustainability of DRR education, including lack of institutional support, inadequate training of school personnel, and difficulties in integrating DRR into existing curricula [16]. A more recent bibliometric and systematic review across 2015–2023 by A review of DRRE implementation: Integration, trends, and trajectories confirms that, despite significant policy efforts worldwide, many implementations remain fragmented, and integration with local context (e.g., cultural practices, community involvement) is still limited [17].

On the other hand, empirical studies highlight promising examples where schools have become meaningful sites for DRR when DRR is systematically incorporated. For instance, in a study from the Philippines, "Implementation of the Public Schools' Disaster Risk Reduction Management Program and Level of Capabilities to Respond," found substantial progress in community engagement, alignment with national DRR policies, and establishment of effective early warning systems in public schools indicating that with the right institutional support, DRR can be operationalized effectively in school settings. Meanwhile, research such as DRRE in Primary Schools in Khyber Pakhtunkhwa, Pakistan, examines enablers and barriers to scaling DRR education among primary school students: factors such as teacher training, resource availability, and school leadership strongly influence the success of DRR education [16].

More recent contributions call for more holistic and inclusive approaches, including disability-inclusive DRR education, community-school partnerships, and adaptation to socio-cultural. For example, Integrating disability inclusive disaster education in primary schools (2025) demonstrates the feasibility and necessity of tailoring DRR content and pedagogical methods to diverse student needs, emphasizing that inclusivity enhances overall school and community resilience [18].

In sum, the literature suggests several recurring themes relevant to our research: first, schools are recognized globally as pivotal for DRR, capable of promoting resilience, awareness, and preparedness [19]. Second, integration of DRR into curricula, institutional policies, and community participation is fundamental for sustainability [20]. Third, despite policy frameworks, practical challenges such as limited resources, fragmented implementation, and lack of local adaptation often hinder effective institutionalization. Finally, emerging studies point to the importance of inclusive, context-sensitive, and community-linked DRR education [21].

These insights provide a theoretical and empirical foundation for the present study's proposition of a hybrid model of disaster-resilient schools, one that combines adaptive institutional arrangements, human resources development, community participation, and integration of local wisdom and technology in alignment with the gaps and opportunities identified in the global literature.

3. METHODS

This study employs a qualitative approach with a case study strategy, selected to capture the complexity of inter-actor relations, institutional dynamics, and social practices that shape the implementation of disaster education in Padang City. The research sites focus on two schools implementing the SPAB program, namely SMAN 1 Padang and SMPN 25 Padang, which were purposively selected because they represent two distinct typologies of resilience: structural–institutional resilience and social–communitarian resilience.

In this study, SMAN 1 Padang and SMPN 25 Padang are positioned as bounded case studies, with the research timeframe covering disaster education implementation and practice from 2019 to 2024, allowing observation of program sustainability, policy changes, and school responses to disaster simulations and training over time. The comparability between the two cases is based on several dimensions: program maturity, hazard exposure, and actor configuration. In terms of program maturity, SMAN 1 Padang represents a school with longer involvement in the SPAB program and relatively established formal institutional support, whereas SMPN 25 Padang reflects a school whose program development has been driven primarily by community initiatives and social networks. Regarding hazard exposure, both schools are located in earthquake- and tsunami-prone areas of Padang City and face comparable disaster risks, enabling the analysis to focus on differences in institutional and social capacity rather than geographical variation.

In terms of actor configuration, both schools engage with BPBD, civil society organizations, and local communities, albeit through different relational patterns, which provides an analytical basis for examining how variations in governance arrangements and community participation shape distinct typologies of school resilience. Accordingly, these cases are not intended to statistically represent all schools in Padang City, but rather to function as analytical cases that facilitate in-depth exploration of the mechanisms and processes involved in the development of disaster-resilient schools.

Beyond the education units, this study also involves the BPBD, the Education Office, the Environmental Agency, the PUPR, the Regional Secretariat, civil society organizations (KOGAMI, Tagana, Jemari Sakato), and Disaster Preparedness Groups (Kelompok Siaga Bencana – KSB) in coastal areas such as Lolong Belanti and Ulak Karang. Data were collected through in-depth interviews with key actors, limited focus group discussions (FGDs), field observations of simulation activities and school infrastructure, as well as document analysis of policy documents, training modules, and program reports.

The inclusion criteria for informants in this study were purposively defined to include individuals who: (1) were directly involved in the formulation, coordination, or implementation of disaster education and the SPAB program; (2) held strategic positions within government agencies, schools, civil society organizations, or community groups; and (3) possessed practical experience in preparedness activities, simulation exercises, or disaster risk management. Based on these criteria, in-depth interviews were conducted with approximately 20–25 informants, including officials and technical staff from the BPBD, representatives from the Education Office and related local government units, school principals and teachers from SMAN 1 and SMPN 25 Padang, representatives of civil society organizations (KOGAMI,

Tagana, and Jemari Sakato), as well as coordinators and members of KSB in coastal areas.

Documents analyzed in this study were selected based on their relevance to disaster education and the implementation of SPAB. These documents included national and local regulations, circular letters, and technical guidelines on SPAB, disaster-safe school training modules, school contingency plans, simulation activity reports, and program documents produced by BPBD and civil society organizations. Document selection was conducted in stages, taking into account their direct relevance to the research focus and the program implementation period.

This study adhered to the ethical principles of social research. All informants were interviewed after receiving an explanation of the research objectives and providing verbal informed consent. Informant confidentiality was maintained through role- and institution-based identification rather than personal names. The study did not directly involve vulnerable populations and posed no physical or psychological risk to participants.

Data analysis was conducted using thematic analysis techniques. The process included open coding of interview transcripts and field notes, grouping codes into categories, and identifying major themes related to institutional patterns, the roles of non-government actors, SPAB implementation practices in schools, structural challenges, and innovations based on local wisdom. The validity of the findings was strengthened through source triangulation (comparing narratives among government actors, schools, and communities), method triangulation (interviews, observation, and document studies), and theoretical triangulation by integrating perspectives from disaster risk management, local government capacity, and critical education. This approach enabled the study to move from empirical description toward the formulation of a conceptual model of disaster-resilient schools that is firmly grounded in the social realities of Padang City.

The thematic analysis in this study was conducted through several systematic stages. The first stage involved initial coding (open coding), in which interview transcripts and field notes were read repeatedly to identify meaning units relevant to the research focus. Initial codes were developed inductively and reflected issues emerging directly from the data, such as patterns of institutional coordination, the roles of non-governmental actors, school practices in SPAB implementation, and the use of local wisdom.

The second stage consisted of axial coding, whereby initial codes were grouped into broader categories based on conceptual and empirical linkages. At this stage, the researchers examined relationships among categories to identify recurring patterns as well as contradictions within the data.

The third stage involved selective coding and theme development, in which the main categories were synthesized into analytical themes representing key dynamics in the development of school resilience. This process resulted in themes such as adaptive institutionalization, the role of civil society organizations as policy entrepreneurs, community-based resilience, and the integration of local wisdom in disaster education.

The analysis process involved two researchers who independently read and interpreted the data, followed by discussions to align interpretations and minimize individual bias. Peer debriefing was conducted periodically to assess the consistency of interpretations and the appropriateness of theme development. Divergent interpretations were resolved through reflective discussion until consensus was reached.

Final themes were determined based on their frequency of occurrence in the data, relevance to the research objectives, and explanatory capacity in capturing inter-actor relationships and institutional processes in disaster education. This approach ensured that the resulting themes were not only internally coherent but also firmly grounded in the empirical data.

4. RESULTS AND DISCUSSION

4.1. From ceremonial coordination to adaptive institutionalization

The findings indicate that the BPBD serves as the central node in the implementation of the SPAB program in schools. BPBD initiates training, mentoring, evacuation simulations, and the preparation of contingency plans in collaboration with schools. However, behind the narrative of success and even the national awards previously received, there lies the reality that many of these activities rely heavily on the personal commitment of individual officials and staff rather than on well-established institutional support. Limited budgets and human resources have resulted in monitoring and evaluation of SPAB being conducted informally, and at times even on a voluntary basis outside official working hours. Consequently, program resilience rests on what may be termed the "individual resilience of bureaucrats," which becomes fragile in the event of leadership rotation or shifts in political priorities.

This partnership was described by the school as follows:

"*BPBD does not only come during simulation activities. They also assist us in preparing the school contingency plan, checking evacuation routes, and providing input on safe assembly points. This support has been very helpful for the school*." (Interview with the Vice Principal of SMAN 1 Padang, 2024).

At the inter-agency level, coordination among the Regional Secretariat, the Education Office, the Environmental Agency, and the PUPR appears to operate mainly at a symbolic level through coordination meetings and policy documents, but has not yet produced operational and measurable collaborative mechanisms. The Education Office, for instance, supports SPAB through teacher training and socialization, yet the integration of disaster education into the formal curriculum remains fragmented. The Environmental Agency contributes through the Adiwiyata and Clean and Healthy Behavior (PHBS) programs, which are relevant to fostering discipline and environmental awareness, but have not been explicitly linked to DRR agendas. Meanwhile, the PUPR Agency holds a strategic mandate to ensure that school infrastructure meets structural mitigation standards; however, spatial planning enforcement in tsunami-prone zones continues to face significant challenges.

These inter-institutional relations are summarized as shown in Table 1.

This table reveals that inter-agency coordination remains at an early formalization stage: roles are defined, yet they are not supported by joint funding mechanisms, cross-sectoral performance indicators, or integrated monitoring and evaluation systems. From the perspective of local government

capacity theory, this condition reflects an institutional structure that has not yet achieved stable adaptive capacity. Therefore, the design of a hybrid model of disaster-resilient schools requires a shift from project-based, ceremonial coordination toward adaptive institutionalization supported by regulatory certainty, sustainable financing, and clearly defined collaboration mechanisms.

Table 1. Roles of local government institutions in SPAB implementation in Padang City

Institution	Main Role	Primary Form of Support	Key Constrain
Padang City BPBD	SPAB coordinator, training and simulations	School mentoring, socialization, contingency planning	Limited HR and budget, dependence on individual figures
Regional Secretariat	Policy reinforcement and inter-agency coordination	Designation of SPAB as a regional priority program	Sectoral coordination is not yet measurable or sustainable
Education Office	Integration of disaster education in schools	Teacher training, circular letters, and school facilitation	Formal curriculum not binding, uneven participation
Environmental Agency	Cultivating discipline and environmental awareness	Adiwiyata and PHBS programs	Link to disaster agenda remains implicit
PUPR Agency	Structural mitigation and school spatial planning	School building construction supervision	Weak spatial enforcement in red zones

Note: SPAB = Disaster-Safe Education Unit (Satuan Pendidikan Aman Bencana); BPBD = Padang City Disaster Management Agency; PUPR = Public Works and Spatial Planning Agency; PHBS = Clean and Healthy Behavior.

4.2 Non-governmental policy entrepreneurs and the implementation bridge

Amid limitations in state capacity, civil society organizations and local communities have emerged as actors filling key implementation gaps. KOGAMI, Tagana, and Jemari Sakato perform distinct yet complementary functions within the disaster education landscape of Padang City. KOGAMI stands out as a pioneer in developing locally based disaster preparedness curricula for coastal schools; Tagana is strong in community and culture-based socialization approaches, including the use of tabuah as an early warning medium; while Jemari Sakato plays a role at the policy advocacy level and in the development of Disaster-Safe School/Madrasah modules.

Their respective roles are summarized in Table 2.

These findings demonstrate that non-governmental organizations function not merely as "implementation partners," but as policy entrepreneurs that initiate innovation, mobilize networks, and advance disaster education policy agendas well before the state establishes formal frameworks such as SPAB. From a governance perspective, their presence expands public participation spaces and enhances system capacity without waiting for regulatory perfection. The hybrid model proposed in this study explicitly positions these actors as integral components of the governance architecture rather than as optional complements.

Table 2. Key contributions of non-governmental organizations in disaster education in Padang City

Organization	Focus	Activities	Achievements	Main Challenges
KOGAMI	Eduaction-disaster ready school curriculum	Local content curriculum, training, and participatory risk mapping	Preparedness curriculum implemented in dozens of coastal schools	Limited funding, cadre regeneration
Tagana	Community- and culture-based socialization and simulations	Tagana goes to school, evacuation drills, and use of tabuah	Intensive outreach in dozens of schools until ±2020	Minimal budget support post-2020
Jemari Sakato	Policy advocacy and empowerment	SMAB modules, risk mapping, advocacy for governor/regional regulations	Drafting of disaster-smart school governor regulation	Regulation not yet enacted, limited human resources

The role of civil society organizations was acknowledged by a government official as follows:

"*Before SPAB became widely recognized, KOGAMI and other civil society organizations had long been working with coastal schools. They were the ones who initially raised awareness about tsunami risks and evacuation. In fact, the government has learned a great deal from their practices.*" (Interview with an official from the Padang City Education Office, 2024).

4.3 Schools as laboratories of resilience: The contrast between SMAN 1 and SMPN 25

At the school level, the study reveals a sharp contrast between institutions that have successfully internalized disaster education and those that implement SPAB only minimally. SMAN 1 Padang and SMPN 25 Padang were selected as case studies because they represent two distinct yet equally relevant resilience typologies for designing a hybrid model.

SMAN 1 Padang is characterized by strong institutional resilience: a formal MoU with BPBD since 2009, routine simulations, the establishment of a School Disaster Preparedness Team, and the integration of disaster topics into learning, particularly through geography courses and extracurricular activities such as Red Cross Youth and scouting.

In contrast, SMPN 25 Padang demonstrates strong social–community resilience. The school has developed tsunami evacuation simulations involving surrounding residents, parents, KOGAMI, Tagana, and local KSB. Simple post-simulation evaluations in the form of reflective student questionnaires are used to improve subsequent exercises. Evacuation routes and safe zones are designed participatorily,

fostering a strong sense of ownership among both the school community and local residents. Although financial and physical infrastructure resources are more limited than at SMAN 1, SMPN 25's strength lies in its social networks and internalization of *gotong royong* values.

A teacher at SMPN 25 Padang explained the challenges related to pedagogical capacity as follows:

"*We have participated in disaster preparedness training, but it was mostly a one-off activity and largely technical in nature. After that, there was no follow-up mentoring. As a result, when we are expected to integrate disaster-related content into everyday teaching, many teachers are still unsure how to do it.*" (Interview with a teacher at SMPN 25 Padang, 2024).

Another teacher added that administrative workload also constitutes a major barrier to the effective internalization of disaster education materials in classroom practice. These differences are summarized in Table 3.

Table 3. Comparison of disaster-resilient school practices: SMAN 1 and SMPN 25 Padang

Aspect	SMAN 1 Padang	SMPN 25 Padang
Resilience Basis	Structural–institutional	Social–community
Cooperation Foundation	Formal MoU with BPBD since 2009	Informal collaboration with BPBD, KOGAMI, Tagana, and KSB
Main Practices	Routine simulations, school disaster team, curriculum integration, risk mapping	Community-based simulations, self-evaluation, participatory evacuation routes
Mitigation Infrastructure	Complete evacuation routes, signage, shelters, and updated maps	Simple evacuation routes, information boards, and community support
Primary Strength	Visionary leadership, relatively strong institutional system	High community participation, strong internalization of local values
Limitations	Curriculum updates and training are not always sustainable	Limited budget and facilities, dependence on partner support

From a critical education theory perspective, these two schools represent two faces of praxis: SMAN 1 illustrates how formal structures can reinforce a culture of disaster awareness, while SMPN 25 demonstrates how disaster education becomes a dialogical process between school and community. The hybrid model proposed in this study seeks to combine the strengths of both institutional firmness and deep social participation so that schools are not merely "resilient on paper" nor "resilient by chance due to strong communities," but are instead resilient in a systemic manner.

4.4 Structural challenges: Budget, teacher capacity, monitoring and evaluation, and regulation

Despite the presence of good practices in several schools and communities, this study identifies four major barriers that consistently disrupt the sustainability of disaster education in Padang City: limited budgets, constrained human resource capacity (especially teachers), weak monitoring and evaluation mechanisms, and the absence of specific local regulations governing SPAB. These four factors are interrelated and form a problematic cycle that shifts programs toward being event-based rather than system-based.

Budgetary constraints for disaster education were explicitly acknowledged by an official from the BPBD:

"*When we talk about the importance of disaster education in schools, we fully agree that it is crucial. However, in reality, the BPBD budget is still heavily oriented toward emergency response and post-disaster rehabilitation. For activities such as SPAB in schools, funding often has to be 'attached' to other programs, which inevitably limits the scale of implementation*." (Interview with a BPBD Padang City official, 2024).

This condition is also reflected in the minutes of an inter-agency coordination meeting, which noted that SPAB activities "do not yet have a dedicated budget line and are still treated as supplementary programs" (Minutes of the SPAB Inter-Agency Coordination Meeting, Padang City, 2024).

Budget constraints are reflected in BPBD expenditure priorities that remain heavily focused on post-disaster response, leaving minimal allocation for education and mitigation. At the school level, most institutions lack a dedicated budget line for disaster education within their School Budget Plans (RKAS), making activities dependent on grants or partner support. Consequently, only well-networked schools remain relatively active, while others lag behind. At the same time, teacher capacity, the core driver of disaster education, is limited due to training that tends to be technical and short-term, without sustained pedagogical reinforcement.

Weak monitoring and evaluation systems exacerbate this condition. Many schools conduct simulations only once every one or two years without structured evaluation of student preparedness or evacuation effectiveness. Documentation from drills is often not archived, let alone analyzed for improvement. At the policy level, the absence of Regional Regulations or Governor Regulations specifically addressing disaster education leaves SPAB without strong legal protection. As a result, programs become highly vulnerable to leadership changes and shifting development priorities.

The absence of a formal post-simulation evaluation mechanism was reflected in a statement by a school principal:

"*We usually still conduct evacuation simulations, but afterward the evaluation is never formally documented. At most, it is briefly discussed in internal meetings. There are no specific instruments to assess whether students truly understand the evacuation routes or not.*" (Interview with a school principal, 2024).

The absence of a local legal framework was further emphasized by a representative from the BPBD:

"The implementation of SPAB in schools across Padang City has not yet been supported by a Regional Regulation or a Mayoral Regulation that specifically governs disaster education. As a result, the sustainability of the program largely depends on the initiatives of individual institutions." (Interview with BPBD Padang City, 2024). These four challenges can be mapped in Table 4.

From an institutional perspective, this condition characterizes SPAB as a fragile institution—formally recognized and practiced in certain areas, yet lacking the regulatory and structural foundations required to endure

contextual change. Therefore, the formulation of the hybrid model of disaster-resilient schools is not merely about adding new programs, but about restructuring the policy ecosystem, budgetary frameworks, and human capacity so that disaster education is no longer treated as a vulnerable extracurricular activity.

Table 4. Key barriers to the implementation of disaster education in Padang City

Main Issue	Field Manifestation	Impact on Disaster-Resilient Schools
Budget limitations	Minimal mitigation funding, schools rely on grants/partners	Uneven activities, only certain schools remain active
Limited human resources	Teachers are not continuously trained, administrative burden dominates	Preparedness values are not internalized in classrooms
Weak M&E systems	Simulations not systematically evaluated, poor documentation	Programs are unsustainable, and progress is difficult to measure
Absence of local regulations	No specific regional/mayor/governor regulation on disaster education	Sustainability depends on individuals and projects

4.5 Local wisdom-based innovation and the formulation of the hybrid model

One of the key findings distinguishing Padang City from many other contexts is the strong role of local wisdom in disaster mitigation practices. In several coastal communities, rapid public responses to strong and prolonged earthquakes are not triggered by formal sirens but by the collective memory of the 2009 earthquake. Residents instinctively move to higher ground without waiting for formal instructions. This pattern demonstrates the functioning of social memory as an experience-based mitigation mechanism, in which knowledge of risk and life-saving action is informally transmitted across generations.

A member of a coastal KSB explained:

"When an earthquake is felt to be strong and prolonged, we already understand that it is a danger signal. There is no need to wait for a siren. The tabuah is immediately sounded so that people know they must move quickly to higher ground. This has long been a shared agreement within the community." (Interview with a KSB member in Ulak Karang, 2024).

The use of tabuah as an early warning instrument by Tagana adds a cultural dimension to the risk communication system. Traditionally used to gather communities for customary events, tabuah has been adapted as a recognizable and socially legitimate danger signal. This approach is not only creative but also reduces the psychological distance between communities and disaster policy, as the instrument used is rooted in cultural symbols with embedded social legitimacy. Meanwhile, values of gotong royong and the informal leadership of ninik mamak and religious figures have proven effective in accelerating collective mobilization during crises.

These findings confirm that resilience in Padang City cannot be understood solely through the structural capacity of government and schools. There is a third operative layer: cultural–community resilience. Building on this recognition, the study formulates a hybrid model of disaster-resilient schools that synergizes four main components:

Adaptive institutionalization, through clear local regulations, cross-sector collaboration forums, and joint monitoring and evaluation mechanisms among BPBD, the Education Office, schools, and civil society partners.

Human resource capacity strengthening, through continuous training for teachers, school principals, and students, that is not merely technical but also pedagogical and reflective.

Community participation, positioning parents, KSB, and local organizations as integral actors in the planning, implementation, and evaluation of SPAB.

Integration of local wisdom and technology, combining cultural symbols and practices (tabuah, gotong royong, social memory) with early warning systems, digital learning platforms, and modern communication media.

Within this framework, schools are positioned as the convergence point of all four components: spaces where formal policy is translated into practice, human capacity is built, communities are engaged, and local wisdom is negotiated alongside modern technological and regulatory demands. The resulting hybrid model is not merely a compromise between the "traditional" and the "modern," but a systemic design that acknowledges resilience as emerging from the creative interaction between the state, schools, and local communities.

From a governance perspective, the term "hybrid" in the proposed disaster-resilient school model refers to the convergence and interaction between formal state mechanisms (such as regulations, the SPAB program, and the roles of BPBD and related government agencies) and non-formal, community-based mechanisms (including civil society organizations, local communities, and local wisdom). This model does not position either the state or the community as a single dominant actor; instead, it emphasizes a polycentric and collaborative governance configuration.

In contrast to technocratic approaches that conceptualize school resilience primarily as compliance with formal standards and procedures, the findings of this study demonstrate that resilience is produced through a combination of institutional capacity, school leadership, social networks, and cultural legitimacy. In this sense, "hybridity" lies in the way community- and culture-based practices do not operate outside the formal system, but instead function as mechanisms that strengthen and fill institutional gaps. This study shows that local culture does not merely serve as a social backdrop but operates as an active mechanism that bridges the gap between formal policy and everyday practices within schools. Practices such as the use of tabuah, the collective memory of the 2009 earthquake, and values of gotong royong function as "social anchoring mechanisms" that make risk messages and preparedness actions more acceptable and practicable for school communities and surrounding residents.

These mechanisms operate through several pathways: first, culture provides social legitimacy for preparedness actions; second, it accelerates the internalization of preparedness values through shared experiences and social learning; and third, it enhances the sustainability of practices when formal institutional support remains limited. Accordingly, the institutionalization of disaster education within the hybrid model does not rely solely on written regulations, but also on

repeated, experience-based processes of value internalization grounded in collective practice.

The findings of this study confirm previous research emphasizing the importance of integrating DRR into curricula, school policies, and community participation [3, 15]. However, this study extends the existing literature by demonstrating that such integration is insufficient if understood merely as an administrative or curricular process.

Unlike descriptive studies that focus on physical preparedness or program compliance, this research adds nuance by highlighting the role of non-state actors as policy entrepreneurs and the function of local wisdom as an effective governance mechanism. In this context, schools are positioned not merely as units of policy implementation but as nodes that connect state policy with community-based resilience practices.

Thus, the proposed hybrid model not only corroborates prior findings but also offers a conceptual framework that explains how and why disaster education can be sustained and scaled in contexts characterized by institutional limitations.

5. CONCLUSIONS

This study demonstrates that disaster education in Padang City has moved beyond a purely introductory phase but has yet to achieve robust and fully embedded institutionalization. While the SPAB program is formally established and several schools and communities exhibit promising practices, disaster education remains uneven, often shifting between ceremonial activities and more substantive, system-oriented approaches.

Drawing on empirical evidence from government agencies, schools, civil society organizations, and community groups, this study proposes a hybrid model of disaster-resilient schools consisting of four interrelated components: (1) adaptive institutionalization, supported by regulatory clarity, cross-sector coordination, and monitoring mechanisms; (2) strengthening human resource capacity, particularly among teachers and school leaders through continuous and reflective learning; (3) community participation, positioning parents, local organizations, and KSB as integral actors rather than peripheral supporters; and (4) integration of local wisdom and technology, where cultural practices such as tabuah, collective disaster memory, and social values are combined with formal early warning systems and educational tools. Together, these components illustrate that school resilience is not the product of infrastructure or policy compliance alone, but emerges from the interaction between formal institutions, social networks, and culturally embedded practices.

The findings further show that schools can function as laboratories of resilience, as illustrated by the contrasting yet complementary cases of SMAN 1 Padang and SMPN 25 Padang. While one emphasizes institutional strength and formal coordination, the other highlights community engagement and cultural embeddedness. This variation underscores the value of a hybrid governance perspective, in which state actors, civil society, and local communities jointly shape sustainable disaster education.

Despite its contributions, this study has several limitations. First, as a qualitative case study focused on Padang City, the findings are analytically rather than statistically generalizable; their transferability to other regions depends on contextual similarities in hazard exposure, institutional capacity, and socio-cultural conditions. Second, the study relies primarily on interviews with key actors involved in disaster education, which may introduce perspective bias despite the use of triangulation. Future research could address these limitations by conducting comparative studies across multiple disaster-prone regions, employing mixed-method approaches, or examining the long-term impacts of disaster education on household and community preparedness.

Overall, the experience of Padang City suggests that moving from ceremonial to systemic disaster education requires more than programmatic compliance. A hybrid model that combines formal governance, human capacity, community participation, and local wisdom offers a viable framework for strengthening school-based disaster resilience in diverse and resource-constrained contexts.

ACKNOWLEDGMENT

The Research Team appreciates and is most grateful to Andalas University for conducting this research.

FUNDING

This research was supported by the Faculty of Social and Political Sciences, Universitas Andalas (Riset Dasar/Terapan Berbasis Jurnal Internasional Bereputasi – RDT/JIR) 2025. Research Grant No.: 198/UN16.08.WDII/PT.01.03/2025. June 4, 2025.

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