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Institutionalizing Risk-Oriented Collaborative Governance for Preventive Landslide Mitigation in Sawahlunto City

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ABSTRACT

Sawahlunto City is a high-risk landslide area in West Sumatra, Indonesia, where recurrent landslides are shaped not only by steep topography and rainfall exposure but also by the institutional capacity of local disaster governance. The study draws on in-depth interviews with 28 informants, consisting of 11 key informants from city-level government and technical agencies and 17 triangulation informants from sub-districts, villages, disaster-resilient village institutions, non-governmental organizations, volunteers, the provincial disaster agency, the local legislature, and community leadership. Fieldwork was conducted between November and December 2025. Data were also collected through non-participatory observation and analysis of eight policy, planning, regulatory, and disaster-risk documents. Using a qualitative case study approach and theory-informed thematic analysis, the study examines four institutional dimensions derived from collaborative governance theory: inclusive participation, collaborative forums, ground rules, and transparency processes. The findings show that Sawahlunto has formal disaster institutions, risk documents, and multi-actor involvement, but collaboration remains reactive-administrative rather than preventive-deliberative. The Disaster Risk Reduction Forum and community-based institutions exist formally, yet they are not routinely activated as risk-based decision arenas. Cross-agency rules remain more developed for emergency response than for pre-disaster mitigation, while transparency is largely administrative and has not yet enabled participatory accountability. The article contributes by explaining how risk information can be translated into collaborative institutional mechanisms through routine risk forums, cross-agency operational rules, participatory monitoring, and implementation indicators for preventive mitigation. These findings are relevant for urban safety and disaster-risk reduction because they show that landslide mitigation requires not only technical hazard control but also an institutional design capable of converting risk knowledge into coordinated preventive action.

1. INTRODUCTION

Indonesia is experiencing an increasing trend of disaster risk that is no longer incidental but structural and recurring. During the 2021–2025 period, thousands of disaster events were recorded annually, affecting millions of people and causing substantial damage to housing and public infrastructure [1]. Although the number of events fluctuates, the scale of impact remains consistently high, indicating that disaster management systems are still dominated by reactive approaches rather than preventive strategies [2-4]. As illustrated in Table 1, large numbers of displaced populations and damaged assets persist each year, reflecting the limited effectiveness of risk reduction efforts at the pre-disaster stage. Indonesia's disaster risk is structural, recurring, and increasingly linked to the interaction between environmental exposure and governance capacity. The country is located along the Pacific Ring of Fire and is characterized by complex geological, hydrometeorological, and climatic conditions. However, the effectiveness of disaster-risk reduction is not determined by hazard exposure alone. It also depends on how public institutions organize cross-sector coordination, translate risk knowledge into planning, and maintain preventive action before disasters occur.

Landslide safety is not achieved only through physical works after slope failure; it also requires institutional arrangements that determine where slope stabilisation is prioritized, which drainage systems are maintained before the rainy season, how early-warning information reaches exposed households, how evacuation routes remain usable, and how land-use control prevents additional settlement exposure in hazardous zones. In this sense, collaborative governance is

treated as a safety-enabling mechanism: it connects technical risk information with decisions that protect settlements, roads, public facilities, and vulnerable households.

Table 1 summarizes national impacts from January 2021 to August 2025. The 2025 figures are treated as partial-year data rather than a complete annual record. Hydrometeorological hazards, including floods, extreme weather, and landslides, consistently dominated the disaster profile during the period.

Within the national context, West Sumatra Province represents one of the most disaster-prone regions in Indonesia due to its geological position along the subduction zone of the Indo-Australian and Eurasian plates and its mountainous topography [5, 6]. These conditions significantly increase susceptibility to landslides, which have become one of the most frequent and damaging hazards in the region [7]. Among the affected areas, Sawahlunto City stands out as a high-risk urban area, characterized by an exceptionally high frequency of landslide occurrences and widespread spatial exposure. As shown in Table 2, Sawahlunto recorded the highest number of landslide events in the province, indicating a concentrated pattern of hazard intensity.

Table 1. Impacts and damage caused by natural disasters in Indonesia

Year	Deaths	Displaced	Damaged Houses	Damaged Facilities	Total Events
2021	728	7,630,692	158,658	4,445	5,402
2022	858	6,144,534	95,403	1,983	3,544
2023	275	8,491,288	47,214	1,291	5,400
2024	239	3,526,054	37,287	706	3,472
2025	299	4,596,315	23,141	475	2,058

Source: Processed by the authors from Regional Disaster Management Agency (Badan Penanggulangan Bencana Daerah, BPBD) Disaster Infographics (2025)

Table 2. Landslide occurrences in West Sumatra

Regency/City	Number of Events
Agam Regency	15
Sijunjung Regency	12
Padang City	12
Tanah Datar Regency	9
West Pasaman Regency	9
50 Kota Regency	8
Bukittinggi City	3
Sawahlunto City	126
Total	**226**

Source: Emergency Operations Control Center for Disaster Management (Pusat Pengendalian Operasi (Penanggulangan Bencana), Pusdalops PB), Regional Disaster Management Agency (Badan Penanggulangan Bencana Daerah, BPBD), West Sumatra Province (2017)

The historical record of landslide events in West Sumatra shows that Sawahlunto recorded 126 landslide events in 2017, the highest number in the provincial dataset for that year. This article does not use the 2017 data to claim that Sawahlunto is currently the highest-risk area in West Sumatra. Instead, the 2017 data are used as historical evidence of an early concentration of landslide events, which is then supported by Sawahlunto's own 2017-2021 disaster history and the 2025 Disaster-Prone Area document. This correction avoids overclaiming while preserving the empirical relevance of the historical dataset.

In practical terms, repeated landslide exposure raises several safety concerns, the stability of slopes close to settlements, the maintenance of drainage channels that may trigger slope saturation, the safety of road corridors used for mobility and evacuation, the condition of houses located on steep or unstable terrain, and the capacity of village-level actors to detect early signs such as soil cracks, blocked drainage, small slips, and unusual water seepage. These concerns require both engineering interventions and a governance system that can prioritize, finance, monitor, and communicate them before disaster occurs.

The high level of landslide risk in Sawahlunto is closely related to its physical and environmental characteristics. Located within the Bukit Barisan mountain range, the city is dominated by steep slopes exceeding 45° in many areas, creating highly unstable terrain conditions [8]. Risk information from the Sawahlunto Disaster-Prone Area document shows that landslide exposure in the city is multidimensional. The 2025 risk assessment identifies 1,143 ha in the high landslide-vulnerability category and 1,472 ha in the moderate category. In addition, Badan Penanggulangan Bencana Daerah (BPBD) impact and exposure records indicate that broader landslide-prone or potentially affected areas across the city reach 7,526 ha, with 41,093 residents exposed and 93 houses affected during 2023–July 2024. The moderate and high vulnerability areas represent classified risk zones in the Kawasan Rawan Bencana (KRB) document, whereas the broader affected-area figure reflects exposure-related planning data used by local disaster management authorities. This distinction is important because preventive mitigation requires not only identifying hazard zones but also linking those zones to exposed settlements, affected households, infrastructure vulnerability, and local planning priorities.

Table 3 demonstrates that landslide risk in Sawahlunto is not merely a geological issue but a systemic urban challenge affecting settlement safety, economic stability, and long-term development sustainability [9-11]. The city's regional capacity index also demonstrates the institutional problem underlying landslide mitigation. The Sawahlunto resilience assessment shows an overall capacity index of 0.56, categorized as moderate. More importantly, the index for policy and institutional strengthening is 0.41, while the effectiveness of disaster prevention and mitigation is only 0.37 (Table 4). These capacity indicators indicate a mismatch between the availability of risk assessment documents and the institutional ability to convert them into preventive mitigation action.

The primary challenge does not lie in the absence of actors [12, 13]. Multiple government agencies and stakeholders, including Regional Disaster Management Agency, Regional Development Planning Agency, Public Works and Spatial Planning Agency, Housing and Settlement Area Agency, Environmental Agency, and local communities, are actively involved in disaster management [14, 15]. However, the presence of numerous actors has not translated into effective risk reduction. This condition suggests that the core issue is not actor availability, but the lack of an integrated and well-structured collaborative governance mechanism capable of supporting preventive mitigation [3, 16]. In many cases, coordination remains ad hoc, event-driven, and weakly institutionalized, limiting the integration of risk information into planning and decision-making processes.

From a governance perspective [17, 18], ineffective collaboration is often characterized by the absence of structured coordination platforms, unclear rules of engagement, fragmented communication, and weak

accountability mechanisms. These limitations result in collaboration that is administrative rather than functional, thereby failing to address the root causes of disaster risk. Consequently, mitigation efforts remain reactive, focusing on post-disaster response instead of systematically reducing exposure and vulnerability.

Table 3. Summary of landslide risk in Sawahlunto City

Indicator	Value
Moderate landslide vulnerability area	1,472 ha
High landslide vulnerability area	1,143 ha
Broader landslide-prone / potentially affected area	7,526 ha
Exposed population	41,093 people
Affected houses	93 units
Rehabilitation budget	Approximately IDR 2 billion

Source: Sawahlunto City Disaster-Prone Area (Kawasan Rawan Bencana, KRB) Document & Regional Disaster Management Agency (Badan Penanggulangan Bencana Daerah, BPBD) (2025)

Table 4. Results of the Sawahlunto City resilience assessment

Priority	Aspect	Index
1	Policy and institutional strengthening	0.41
2	Risk assessment and integrated planning	0.80
3	Development of information systems, training, and logistics	0.61
4	Thematic management of disaster-prone areas	0.58
5	Effectiveness of disaster prevention and mitigation	0.37
6	Preparedness and emergency response	0.70
7	Post-disaster recovery system	0.45
	Total regional capacity index	0.56 (Moderate)

Source: Sawahlunto City Disaster-Prone Area (2025)

Although previous studies have extensively examined hazard mapping [19, 20], vulnerability assessment [21, 22], and disaster impacts in Sawahlunto [23, 24], limited attention has been given to the institutional design of collaborative governance as a key determinant of mitigation effectiveness. This gap raises a critical question: why do landslide risks and their impacts continue to persist despite the availability of risk data and the involvement of multiple actors? Addressing this question requires a shift from analyzing outcomes to examining the underlying governance structures that shape mitigation performance.

Therefore, this study aims to analyze the institutional design of risk-oriented collaborative governance in preventive landslide mitigation in Sawahlunto City and to formulate a conceptual-operational model derived from qualitative case study findings.

2. LITERATURE REVIEW

2.1 Landslide governance and preventive mitigation

Landslide mitigation is often approached through physical and technical measures such as slope stabilization, drainage improvement, hazard mapping, early warning, and land-use control. These measures are essential for reducing physical exposure. However, technical measures become ineffective when they are not embedded in governance systems that decide which locations are prioritized, which institutions are responsible, how resources are allocated, and how communities are informed. Landslide governance therefore requires both technical risk knowledge and institutional mechanisms for preventive action.

Safety-oriented landslide mitigation normally combines structural and non-structural measures. Structural measures include slope stabilisation, retaining structures, drainage improvement, road-slope protection, and protection of critical public infrastructure. Non-structural measures include hazard and susceptibility mapping, rainfall-based early warning, evacuation planning, land-use regulation, public education, community monitoring, and maintenance protocols. A governance approach becomes relevant because these measures require prioritisation across agencies and budget cycles. Without collaborative decision rules, hazard maps may remain technical documents, early-warning coverage may not reach the most exposed communities, and slope-protection works may be implemented only after repeated damage occurs.

Studies on landslide risk commonly emphasize hazard susceptibility, vulnerability assessment, and local exposure. These studies are necessary, yet they often stop at producing risk information. The remaining gap is how risk information flows into institutional decision-making. In high-risk urban areas such as Sawahlunto, this means asking whether hazard maps are used in development control, whether exposed settlements are prioritized in budget planning, and whether local communities participate in defining risk-reduction priorities.

2.2 Collaborative governance and institutional design

Collaborative governance refers to public decision-making arrangements in which government agencies and non-state actors engage collectively in problem solving, deliberation, and policy implementation. In disaster management, collaboration is necessary because risk reduction involves multiple sectors, including spatial planning, public works, housing, environment, community development, emergency response, and budgeting. Yet collaboration does not work merely because many actors are present. It depends on institutional design: who is included, what forum is used, what rules guide interaction, and how transparency and accountability are maintained.

The institutional design perspective is especially relevant for disaster mitigation because many local governments already have disaster agencies, coordination teams, and community-based initiatives. The problem is often not institutional absence but institutional underperformance. Forums may exist formally but not function deliberatively; rules may exist but remain normative; communities may be invited but not empowered; and information may be published without enabling accountability. This article therefore treats collaborative governance as an institutional design problem.

A substantial body of literature conceptualizes collaborative governance primarily as a process of interaction among stakeholders, including dialogue, coordination, and the formation of shared commitments in disaster management, particularly in landslide mitigation [25-27]. Previous studies highlight the importance of cross-sector collaboration but consistently identify recurring challenges, such as weak

coordination, limited stakeholder participation, and fragmented inter-agency relationships [28-30]. Although elements such as trust, commitment, and information sharing have been recognized, collaborative practices remain constrained by low engagement intensity, insufficient institutional support, and limited resource integration [31-33].

These studies reveal a consistent empirical pattern: collaborative governance in disaster mitigation frequently encounters barriers related to non-inclusive participation, weak coordination forums, and limited institutional capacity. However, most existing research remains descriptive and evaluative, offering normative recommendations without sufficiently explaining how collaborative structures and institutional mechanisms should be systematically designed [34-36]. As a result, collaborative governance is predominantly understood as a process rather than as an institutional design problem.

This limitation becomes critical in the context of preventive disaster mitigation, particularly in high-risk urban areas. Preventive mitigation requires long-term, cross-sectoral, and risk-informed coordination that must be embedded within institutional structures and development planning systems. Existing studies have not adequately addressed how institutional arrangements can support such preventive and risk-oriented approaches.

Furthermore, the literature tends to emphasize actor roles and collaborative processes, while the institutional dimension, such as formal forum design, rules of engagement, coordination mechanisms, and transparency systems, remains underexplored [37-39]. This is significant, as many collaboration failures are fundamentally institutional rather than procedural in nature.

2.3 Risk-informed planning

Risk-informed planning requires the systematic use of hazard, exposure, vulnerability, and capacity data in public decision-making. In disaster governance, risk information should guide spatial planning, infrastructure investment, community preparedness, budget allocation, and monitoring. A risk-oriented approach is not achieved simply by possessing hazard maps or risk assessments. It is achieved when such data become the basis for prioritizing locations, allocating responsibilities, and evaluating mitigation performance.

In Sawahlunto, the existence of risk-assessment documents and spatial exposure data creates an important opportunity for preventive mitigation. However, the key question is whether these data are used through collaborative mechanisms. Risk information must move from technical documents into forums, work plans, operational rules, and public accountability processes. This is the missing link addressed in this study.

2.4 Indonesian disaster governance context

Indonesia's disaster governance system has formally shifted from emergency response toward disaster risk reduction after the post-2004 institutional reforms. The establishment of BNPB and BPBD, disaster management plans, contingency plans, and minimum service standards reflects this transformation. However, local implementation often remains path dependent. Emergency-response routines are more familiar, better institutionalized, and more visible than long-term preventive mitigation. This creates a gap between national policy paradigms and local governance practices.

Sawahlunto reflects this broader Indonesian governance challenge. The city has formal disaster institutions, risk documents, and community-based initiatives such as Destana, yet mitigation remains dominated by administrative reporting, emergency response, and sectoral implementation. This condition provides the empirical basis for examining how collaborative governance can be redesigned to become preventive, risk-oriented, and operational.

The literature reveals four layered gaps. First, landslide studies often generate risk knowledge but insufficiently explain the institutional pathway through which risk knowledge shapes decisions. Second, collaborative governance studies often emphasize interaction and stakeholder roles but pay less attention to operational institutional design. Third, risk-informed planning studies call for evidence-based decision-making but rarely specify the collaborative forums and rules needed to convert risk data into action. Fourth, studies on Indonesian disaster governance show policy reform but still require case-based explanation of why local mitigation remains reactive. This article addresses these gaps through a qualitative case study of Sawahlunto City.

3. METHOD

3.1 Research design

This study employed a qualitative case study approach to examine the institutional design of collaborative governance in landslide disaster mitigation in Sawahlunto City [40]. A case study design was selected because the research focuses on a specific high-risk urban context where institutional arrangements, actor relations, and risk-information use must be understood in depth. The study did not use grounded theory. Instead, it used theory-informed thematic analysis, with themes derived from collaborative governance theory and refined through empirical data.

3.2 Study area and unit of analysis

The study was conducted in Sawahlunto City, West Sumatra, Indonesia, a high-risk urban area characterized by steep topography, post-mining landscapes, and high exposure to landslide hazards [23]. These characteristics make the city a relevant case for analyzing risk-oriented governance in disaster mitigation (Figure 1).

Figure 1. Research location
Source: Google map Sawahlunto City (2026)

The unit of analysis in this study is the institutional

configuration of local governance systems, particularly focusing on inter-organizational coordination, collaborative mechanisms, and decision-making processes in landslide mitigation. The analysis examines the structure and interaction of actors across sectors, the operationalization of coordination mechanisms, and the integration of risk information into planning and implementation processes. It also assesses how these institutional components function as a system in supporting, or constraining, the development of a preventive and risk-oriented mitigation.

3.3 Data sources and collection methods

This study utilizes both primary and secondary data. Primary data were collected through semi-structured interviews with key stakeholders, including local government agencies, technical institutions, and community actors involved in disaster mitigation. The interview protocol was designed based on four institutional dimensions: inclusive participation, collaborative forums, rules of engagement, and transparency mechanisms.

Secondary data were obtained from policy documents, disaster risk assessments, and planning reports to identify formal institutional arrangements and the integration of risk information into governance practices (see Table 5).

3.4 Informants and fieldwork period

Informants were selected through purposive sampling based on their formal roles, involvement in landslide mitigation, and ability to explain collaborative governance practices. The research involved 28 informants: 11 key informants and 17 triangulation informants. Fieldwork was conducted from 17 November to 12 December 2025, followed by document collection, triangulation, and data analysis until the end of December 2025 (see Table 6).

Table 5. Documents analyzed in the study

No	Type of Document	Source
1	Disaster Management Law	Disaster Management Agency (national-level)
2	Government Regulation on Disaster Management	Disaster Management Agency (national-level)
3	Regional Regulation on Disaster Management	Regional Disaster Management Agency (provincial-level)
4	Sawahlunto City Disaster Risk Assessment	Regional Disaster Management Agency (city-level)
5	Sawahlunto City Disaster Management Plan	Regional Disaster Management Agency (city-level)
6	Regional Disaster Management Agency Strategic Plan	Regional Disaster Management Agency (city-level)
7	Disaster potential and impact data	Disaster Management Agency (national-level) and Disaster Management Agency (provincial-level)

Table 6. Informant categories and interview periods

Code	Category / Institution	Number	Role in the Study	Interview Period
I1	City Secretary / local government leadership	1	Strategic coordination and policy direction	17 Nov 2025
I2-I7	BPBD Sawahlunto	6	Disaster coordination, prevention, emergency response, rehabilitation and reconstruction	19-21 Nov 2025
I8	Housing and Settlement Area Agency / Perkim	1	Housing damage, settlement risk, post-disaster rehabilitation	25 Nov 2025
I9	Environmental Agency / DLH	1	Environmental control and land-use concerns	25-26 Nov 2025
I10	Bappeda Sawahlunto	1	Planning, budgeting, and cross-sector program integration	25 Nov 2025
I11	Public Works and Spatial Planning Agency / PUPR	1	Infrastructure, roads, drainage, slope-related technical works	26 Nov 2025
T1-T2	Sub-district heads	2	Territorial coordination and information relay	1-5 Dec 2025
T3-T11	Village/urban-village/Destana actors	9	Local mitigation, community participation, village planning	1-5 Dec 2025
T12	Disaster volunteer / Tagana	1	Volunteer support and emergency collaboration	8-12 Dec 2025
T13-T14	NGO / civil society organizations	2	Advocacy, public participation, disaster education	8-12 Dec 2025
T15	BPBD West Sumatra Province	1	Provincial policy and disaster-risk coordination	15 Dec 2025
T16	DPRD Sawahlunto	1	Budgeting and legislative oversight	27-28 Nov 2025
T17	Community / customary leader	1	Social legitimacy and community participation	8-12 Dec 2025

3.5 Data analysis

Data analysis was conducted through theory-informed thematic analysis [41, 42]. First, interview transcripts, observation notes, and documents were read repeatedly to identify statements related to actor involvement, forum operation, rules, transparency, and risk-information use. Second, initial codes were organized into four main institutional themes: inclusive participation, collaborative forums, ground rules, and transparency processes. Third, subthemes were compared across actor categories and data sources to identify convergence and divergence. Fourth, the findings were synthesized into an operational conceptual model showing how risk knowledge can be translated into preventive collaborative governance.

Because the coding was guided by prior collaborative governance theory, the analysis is not presented as pure grounded theory. The analytical procedure is abductive: it moves between theory and empirical evidence. This enables the study to retain theoretical coherence while remaining grounded in Sawahlunto's institutional realities.

3.6 Model development, member checking, and expert feedback

The conceptual-operational model was derived through three steps. First, empirical findings from interviews, observation, and documents were grouped under four institutional dimensions: inclusive participation, collaborative forums, ground rules, and transparency processes. Second, these institutional findings were connected with risk-information categories found in the thesis data, including hazard maps, exposed-population data, affected-house records, disaster-history data, SPM indicators, spatial-planning documents, and village-level observations. Third, the model was formulated by identifying the institutional pathway needed to move from risk knowledge to risk-based decisions, preventive mitigation outputs, and qualitative safety outcomes.

The model was not validated through a formal quantitative test or external expert-panel scoring. Therefore, it is presented as a conceptual-operational model derived from a qualitative case study, not as a statistically validated predictive framework. Credibility was strengthened through triangulation across interviews, documents, and observations, and through informal member checking during field confirmation with selected local stakeholders. Feedback from local actors was used to ensure that the proposed institutional components reflected Sawahlunto's governance context, especially the roles of BPBD, Bappeda, PUPR, Perkim, DLH, sub-districts, villages, Destana, NGOs, volunteers, and community representatives.

3.7 Ethics, consent, and validity

All informants were informed about the purpose of the study before the interviews. Their participation was voluntary, and interview data were anonymized using informant codes in the article. Validity was strengthened through source triangulation by comparing interview data with observation notes and policy documents [43]. Data collection continued until the major themes recurred across informant categories, indicating thematic saturation. The conceptual-operational model was derived from the convergence of interview evidence, document analysis, observation, and synthesis of the four institutional dimensions.

4. RESULTS

4.1 Existing institutional condition: Formal structure but reactive practice

This section examines the existing institutional conditions of landslide mitigation in Sawahlunto City, focusing on governance patterns, institutional performance, and systemic gaps that shape current mitigation practices. By analyzing these elements, the study aims to assess the extent to which existing institutional arrangements support, or constrain, the transition toward a preventive and risk-oriented mitigation approach.

The findings indicate that landslide disaster mitigation in Sawahlunto City has evolved in alignment with national disaster management policies, particularly following the post-2004 paradigm shift from emergency response toward disaster risk management. This shift has been institutionally reflected in the establishment of national and local disaster management agencies, as well as the development of risk assessment and planning instruments. However, empirical evidence shows that this transformation has not been fully internalized at the local implementation level.

In practice, the institutional pattern of disaster mitigation in Sawahlunto remains predominantly reactive. Cross-sector collaboration among government agencies, local authorities, communities, and volunteers tends to intensify during disaster events, enabling relatively rapid coordination and response. In contrast, during the pre-disaster phase, collaboration is weak, irregular, and not systematically institutionalized. This pattern indicates that mitigation activities are largely event-driven rather than embedded within routine governance processes.

Such a reactive pattern reflects a form of path dependency in disaster governance, where institutional practices continue to prioritize emergency response despite the increasing need for preventive mitigation in a high-risk environment. Landslide mitigation has not yet been positioned as a continuous and integrated cross-sectosr development agenda, but rather remains an administrative function activated primarily during crisis situations [6, 8]. As a result, there is a structural mismatch between the intensity of landslide risk and the governance design intended to manage it.

This condition is further reinforced by the analysis of Minimum Service Standards (Standar Pelayanan Minimal, SPM) in disaster management, which provides a measurable indicator of institutional performance. As shown in Table 7, the overall SPM achievement in Sawahlunto City reached only 60.54%, indicating moderate capacity. More importantly, a significant imbalance exists between different service components. Prevention and preparedness services achieved only 10%, while rescue and evacuation services reached nearly 90%. These findings suggest that institutional capacity is heavily concentrated in post-disaster response, while preventive and anticipatory functions remain underdeveloped.

Table 7. Achievement of minimum service standards in disaster management, Sawahlunto City

Type of Disaster Service	Achievement (%)	Performance Interpretation
Disaster-prone information	81.67	Administrative and informative
Prevention and preparedness	10.00	Very low
Rescue and evacuation	89.94	Relatively strong
Total Disaster SPM	60.54	Moderate capacity

Source: Regional Disaster Management Agency Sawahlunto City (2026)

Interview evidence confirms this imbalance. A BPBD prevention official explained that BPBD's mandate is primarily non-structural prevention, while physical mitigation depends on technical agencies:

"BPBD is more responsible for non-structural prevention, socialization, and the formation of Destana. Physical works such as slope reinforcement or drainage are the domain of technical agencies. But in practice, these matters are often still considered BPBD's responsibility." (I3, BPBD Prevention and Preparedness, 19 Nov 2025).

A Bappeda informant similarly emphasized the incomplete integration of disaster issues into cross-sector planning:

"Disaster issues are already included in planning, but they are not yet strongly integrated across sectors. Each agency still

runs according to its own priorities, so program synchronization remains a challenge." (I10, Bappeda, 25 Nov 2025).

From a risk-oriented perspective, this imbalance highlights the limited integration of hazard, exposure, and vulnerability considerations into institutional planning and coordination mechanisms. Preventive mitigation requires sustained collaboration across sectors, including spatial planning, land-use regulation, infrastructure management, and community-based risk reduction. However, the findings reveal that technical agencies such as Ministry of Public Works and Housing (Kementerian Pekerjaan Umum dan Perumahan Rakyat, PUPR), Department of Housing and Settlement Areas (Dinas Perumahan dan Kawasan Permukiman, Perkim), Environmental Agency (Dinas Lingkungan Hidup, DLH), and Regional Development Planning Agency (Badan Perencanaan Pembangunan Daerah, Bappeda) are not yet systematically integrated into a unified mitigation arrangement.

This fragmentation indicates the absence of a deliberately designed collaborative governance structure capable of aligning sectoral roles into a coherent, risk-informed mitigation system. Consequently, disaster institutions in Sawahlunto function effectively under command-based emergency conditions but lack the institutional capacity to support continuous, preventive, and coordinated mitigation efforts. In the context of a high-risk urban area, these conditions underscore a critical gap between existing institutional arrangements and the requirements of a preventive, risk-oriented governance.

4.2 Inclusive participation: Broad actor presence but unequal decision-making

The findings indicate that actor participation in landslide disaster mitigation in Sawahlunto City is quantitatively broad but qualitatively limited in terms of inclusiveness and equality. A wide range of actors, including regional government agency, technical agencies, sub-district and village administrations, Disaster Resilient Villages, non-governmental organizations, and local communities, are formally involved in disaster management. However, this involvement is not consistently structured across different phases of mitigation, particularly in the pre-disaster stage where long-term planning and risk reduction should be prioritized.

Participation patterns reveal a clear imbalance between disaster phases. Community groups and non-governmental actors tend to be actively engaged during disaster events, particularly in evacuation, emergency response, and early recovery activities. In contrast, their involvement in mitigation planning remains minimal and is largely confined to roles as information recipients or technical implementers. This condition indicates that participation is predominantly procedural rather than deliberative, with limited opportunities for meaningful engagement in decision-making processes related to long-term risk reduction.

As illustrated in Table 8, the collaborative structure is strongly dominated by Regional Disaster Management Agency as the central coordinating and decision-making actor. Technical agencies and local administrative units primarily function as sectoral implementers, while community actors and non-governmental organizations are positioned as supporting actors whose participation is often incidental and event-driven. This structure reflects a hierarchical pattern of collaboration, where authority and decision-making are concentrated rather than distributed.

Table 8. Patterns of actor participation in landslide disaster mitigation

Actor	Form of Participation	Dominant Phase
Regional Disaster Management Agency	Main coordinator, decision-maker	Pre-disaster & emergency
Technical Regional Government Agency	Sectoral implementers	Emergency
Sub-district & village	Field implementers	Emergency
Destana & community	Local response & self-help	Emergency
Disaster NGOs	Technical support & advocacy	Incidental

The unequal pattern is visible in the statement of a technical-agency informant:

"In PUPR, our authority is physical work, such as roads, drainage, or slope protection. Usually we move after an incident or after a recommendation from BPBD. Before an incident, there is not yet a special scheme requiring us to work together from the beginning." (I11, PUPR, 26 Nov 2025).

At the community level, participation is stronger in self-help practices than in formal decision-making. A village head explained:

"In Lumindai, when heavy rain occurs, people are used to working together, cleaning water channels and checking slopes; they do not wait for a major incident first." (T4, Village Head of Lumindai, 2 Dec 2025).

However, NGO participation remains limited in policy direction:

"We are often asked to help with activities or provide input, but in determining the direction of mitigation policy, we are rarely directly involved." (T13, KOGAMI, 9 Dec 2025).

These findings indicate that participation is broad in actor coverage but limited in deliberative equality. Communities and NGOs contribute knowledge and operational support, but they are not yet institutionalized as co-decision-makers in preventive mitigation.

While such centralization contributes to operational efficiency during emergency response, it simultaneously constrains the development of shared decision-making mechanisms and limits the integration of diverse perspectives. There is no institutionalized mechanism that ensures the systematic inclusion of community knowledge, local experience, or non-governmental inputs in the formulation of mitigation strategies. As a result, collaboration tends to reinforce administrative coordination rather than enabling collective problem-solving.

From an institutional design perspective, these findings suggest that inclusive participation has not yet been embedded as a core principle of collaborative governance. Instead, participation functions as a complementary element activated primarily during emergency situations, rather than as a sustained mechanism for preventive mitigation. In the context of a high-risk disaster environment, such limitations reduce the capacity of the governance system to integrate diverse knowledge, strengthen social ownership, and support adaptive and sustainable mitigation strategies. Consequently, the absence of inclusive and deliberative participation weakens

the effectiveness of preventive mitigation and underscores the need for a more structured and participatory governance.

4.3 Key components of collaborative governance design

Collaborative governance in disaster risk management requires not only the presence of multiple actors but also a well-structured institutional design that enables sustained interaction, coordination, and accountability. This study adopts four key components of collaborative governance design, inclusive participation, collaborative forums, rules of engagement, and transparency mechanisms, as analytical lenses to assess the effectiveness of landslide mitigation governance in Sawahlunto City. These components are interdependent and collectively shape the capacity of governance systems to move from reactive responses toward preventive and risk-oriented strategies.

Sawahlunto has formal collaborative arrangements such as the Disaster Risk Reduction Forum and Disaster-Resilient Villages. Nevertheless, these forums have not functioned as routine, risk-based deliberative arenas. Meetings are generally situational, and coordination is often carried out through direct communication or informal groups rather than scheduled cross-sector forums.

4.3.1 Inclusive participation

Inclusive participation is a fundamental element of collaborative governance, ensuring that all relevant stakeholders, government agencies, communities, private actors, and civil society organizations, are meaningfully involved in decision-making processes. In the context of landslide mitigation, inclusiveness is particularly crucial due to the localized nature of risks and the importance of community knowledge.

However, the findings indicate that participation in Sawahlunto remains uneven and predominantly government-driven. Non-government actors, particularly local communities in high-risk areas, are often positioned as passive recipients rather than active contributors in planning and mitigation processes. This limits the integration of local knowledge and reduces the legitimacy and effectiveness of mitigation strategies. Consequently, participation tends to be procedural rather than substantive, weakening the collaborative foundation of governance.

4.3.2 Collaborative forums

Collaborative forums function as institutional spaces where stakeholders interact, deliberate, and coordinate actions. Ideally, these forums operate continuously and serve as arenas for consensus-building and joint decision-making [43]. The study found that Sawahlunto City formally has collaborative forums such as the Disaster Risk Reduction Forum (Forum Pengurangan Risiko Bencana, FPRB). However, functionally, this forum has not operated as an active and sustainable deliberative arena. Forum meetings are not conducted regularly, discussion agendas are situational, and strategic mitigation decisions are rarely produced through the forum.

Cross-sector coordination more frequently occurs through informal channels or ad hoc communication, particularly during disaster events. This condition causes the collaborative forum to lose its strategic function as a space for consensus building, role distribution, and alignment of mitigation programs (Table 9).

A BPBD official explained:

"Cross-sector meetings usually occur when there is an incident or emergency condition. For routine meetings specifically on mitigation, they have not yet been implemented." (I2, BPBD Head, 20 Nov 2025).

Another BPBD official added:

"Coordination exists, but more often through direct communication or groups. Official cross-sector meetings are not often conducted." (I4, BPBD Prevention and Preparedness Section, 20 Nov 2025).

A sub-district head confirmed that mitigation is not a regular agenda:

"Sub-district meetings have many agendas. Landslide mitigation is usually not included as a routine agenda unless there is an incident or a field report." (T1, Silungkang Sub-district Head, 3 Dec 2025).

Thus, the forum problem is not absence but weak operationalization. Formal forums do not yet operate as arenas for joint risk interpretation, priority-setting, role allocation, and preventive monitoring.

Table 9. Condition of collaborative forums in landslide disaster mitigation

Aspect	Empirical Findings
Forum existence	Formally established
Meeting intensity	Not routine
Pre-disaster mitigation agenda	Limited
Non-government actor involvement	Low

Conceptually, the collaborative forum in Sawahlunto has not yet fulfilled the characteristics of an effective collaborative arena, as it has not been able to function as a sustainable center for joint decision-making and cross-sector coordination. From an institutional design perspective, the existence of formal forums without routine operationalization indicates that collaboration is not structurally embedded within governance processes. The forum operates more as a symbolic institutional element rather than a functional coordination mechanism.

In high-risk disaster settings, collaborative forums should serve as permanent and structured platforms for preventive planning. However, in Sawahlunto, they remain largely reactive and event-driven. This weakens the governance system's capacity to generate anticipatory and integrated mitigation strategies.

4.3.3 Rules of engagement

Rules of engagement refer to the formal and informal norms that regulate roles, responsibilities, and interactions among stakeholders in collaborative processes. Clear and operational rules are essential to ensure coordination, reduce ambiguity, and strengthen accountability. The findings show that Sawahlunto City has established various disaster-related regulatory instruments, including the Disaster Risk Assessment document, the Disaster Management Plan, and Regional Disaster Management Agency Standard Operating Procedures. However, the ground rules of collaboration predominantly focus on emergency response rather than pre-disaster mitigation.

Rules governing cross-sector role distribution among regional government agencies in landslide mitigation remain general and normative. As a result, coordination lacks clarity, and institutional responsibilities are not effectively operationalized. Moreover, weak enforcement of spatial planning regulations and development control in landslide-prone areas contributes to recurring disaster risks.

The absence of pre-disaster operational rules was expressed clearly by a BPBD official:

"The SOP mostly regulates emergency response. For pre-disaster coordination, there is not yet a specific SOP regulating cross-agency coordination." (I4, BPBD Prevention and Preparedness Section, 20 Nov 2025).

At the technical level, enforcement is difficult:

"The rules exist, but field supervision is not always easy. Sometimes buildings have already been constructed before the problem is known." (I11, PUPR, 26 Nov 2025). A village informant also noted uncertainty in using village resources for mitigation:

"We want to use village funds for mitigation, but we are often hesitant. We are afraid of violating the rules because there are many regulations and sometimes different interpretations." (T9, Village Head of Kubang Tangah, 4 Dec 2025).

These findings show that the institutional rules are not yet sufficient to guide preventive mitigation. They do not clearly define who must act, what data should be used, when coordination must occur, and how compliance should be monitored.

4.3.4 Transparency mechanisms

Transparency mechanisms are critical for ensuring accountability and enabling public oversight in collaborative governance. Transparency should not only involve information disclosure but also facilitate meaningful participation in monitoring and evaluation processes. In Sawahlunto City, disaster-related information and budget allocations are formally available. However, transparency remains largely administrative and has not translated into substantive community engagement (Table 10).

Table 10. Synthesis of ground rules and transparency

Aspect	Empirical Condition
Collaborative ground rules	Present, but normative
Rule enforcement	Weak
Information transparency	Administrative

The technical availability of data was acknowledged by BPBD:

"Incident data and hazard maps are available in BPBD. They become the basis for us in preparing disaster plans and steps." (I2, BPBD Head, 20 Nov 2025).

Yet community understanding remains limited:

"People usually realize that their area is prone to disaster after an incident occurs. Not all people know or understand the hazard map." (T1, Silungkang Sub-district Head, 5 Dec 2025).

Budget transparency also remains formal:

"The APBDes banner is installed, but people rarely really understand its content. They see numbers, but they do not know what they are for, including mitigation." (T9, Village Head of Kubang Tangah, 4 Dec 2025).

Decision transparency is similarly limited:

"For major policies or steps, they are usually discussed at the city level. After that, we deliver them to sub-districts and villages for implementation." (I2, BPBD Head, 20 Nov 2025).

The findings indicate that transparency has not become a participatory accountability mechanism. It has not yet enabled communities and non-governmental actors to question priorities, monitor mitigation progress, or participate in evaluating risk reduction.

This indicates that transparency has yet to evolve into a participatory mechanism that empowers stakeholders. Instead, it functions primarily as a procedural requirement. Furthermore, the absence of operational ground rules for preventive mitigation reflects a lack of institutional clarity in coordinating long-term, cross-sector actions in high-risk environments.

4.4 Synthesis: Toward a risk-oriented collaborative governance

The synthesis of the findings reveals that collaborative governance in landslide disaster mitigation in Sawahlunto City is characterized by institutional fragmentation and reactive orientation. Although key components of collaborative governance, participation, forums, rules of engagement, and transparency, are formally present, they are not yet functionally integrated into a coherent and preventive governance system.

First, inclusive participation remains limited and uneven, with non-government actors positioned more as passive recipients than active contributors. This weakens the integration of local knowledge and reduces collective ownership of mitigation efforts. Second, collaborative forums, while formally established, lack routine deliberative functions and fail to serve as sustainable arenas for coordination and joint decision-making. Third, rules of engagement are largely normative and oriented toward emergency response, resulting in unclear role distribution and weak enforcement, particularly in spatial planning and risk control. Finally, transparency mechanisms remain administrative in nature and have not evolved into participatory accountability systems.

These components are not only individually weak but also structurally disconnected. The absence of interaction among these elements prevents the formation of a cohesive governance system capable of anticipating and reducing disaster risk. For instance, weak forums limit meaningful participation, unclear rules hinder effective coordination, and administrative transparency fails to generate collective accountability. As a result, collaborative governance operates as an event-driven coordination mechanism, activated primarily during disaster response rather than functioning as a continuous preventive system.

This condition leads to what can be conceptualized as a reactive institutional design, where governance arrangements respond to disasters after they occur rather than systematically addressing underlying risks. In a high-risk environment such as Sawahlunto, this reactive orientation is insufficient, as it fails to address the structural and recurring nature of landslide hazards.

Risk information exists in Sawahlunto through KRB documents, hazard maps, exposed-population data, settlement damage records, and SPM indicators. However, its use remains uneven. Risk data are more visible in technical documents and administrative reporting than in routine cross-sector decisions. The key institutional gap is the absence of a mechanism that requires BPBD, Bappeda, PUPR, Perkim, DLH, sub-districts, villages, and community actors to jointly interpret risk data and translate them into annual mitigation priorities.

The risk-information flow required for a truly risk-informed model can be described as follows. Hazard maps and slope-risk data should first identify priority locations, particularly villages and urban villages with repeated landslide events and steep settlement exposure such as Lumindai, Silungkang Oso,

Tumpuak Tangah, and Kubang Tangah. Exposed-population and affected-house data should then identify which households require risk communication, preparedness support, relocation consideration, or housing rehabilitation. Community-level observations should identify micro-risk points, including cracks, saturated slopes, blocked drainage, and unstable road edges. These three forms of risk information should be brought into a routine collaborative forum where BPBD, Bappeda, PUPR, Perkim, DLH, sub-districts, villages, Destana, NGOs, and community representatives jointly determine priorities, responsibilities, budgets, and monitoring indicators.

In the current arrangement, this flow remains incomplete. Risk information is available but does not consistently move into joint priority-setting. Hazard maps are held in technical documents, population exposure is used mainly for reporting, and community observations are often treated as incident reports rather than planning inputs. The current pattern can therefore be summarized as follows: Sawahlunto has risk knowledge, but it lacks a stable risk-governance pathway. Hazard and exposure data do not automatically produce preventive action because the collaborative forum, ground rules, and transparency mechanisms are not yet sufficiently institutionalized. This is the empirical basis for the conceptual-operational model proposed in the discussion section.

4.5 Proposed conceptual operational model for preventive landslide mitigation

Building on the synthesis of empirical findings, this study proposes a conceptual operational model risk-oriented collaborative governance for preventive landslide mitigation, as illustrated in Figure 2.

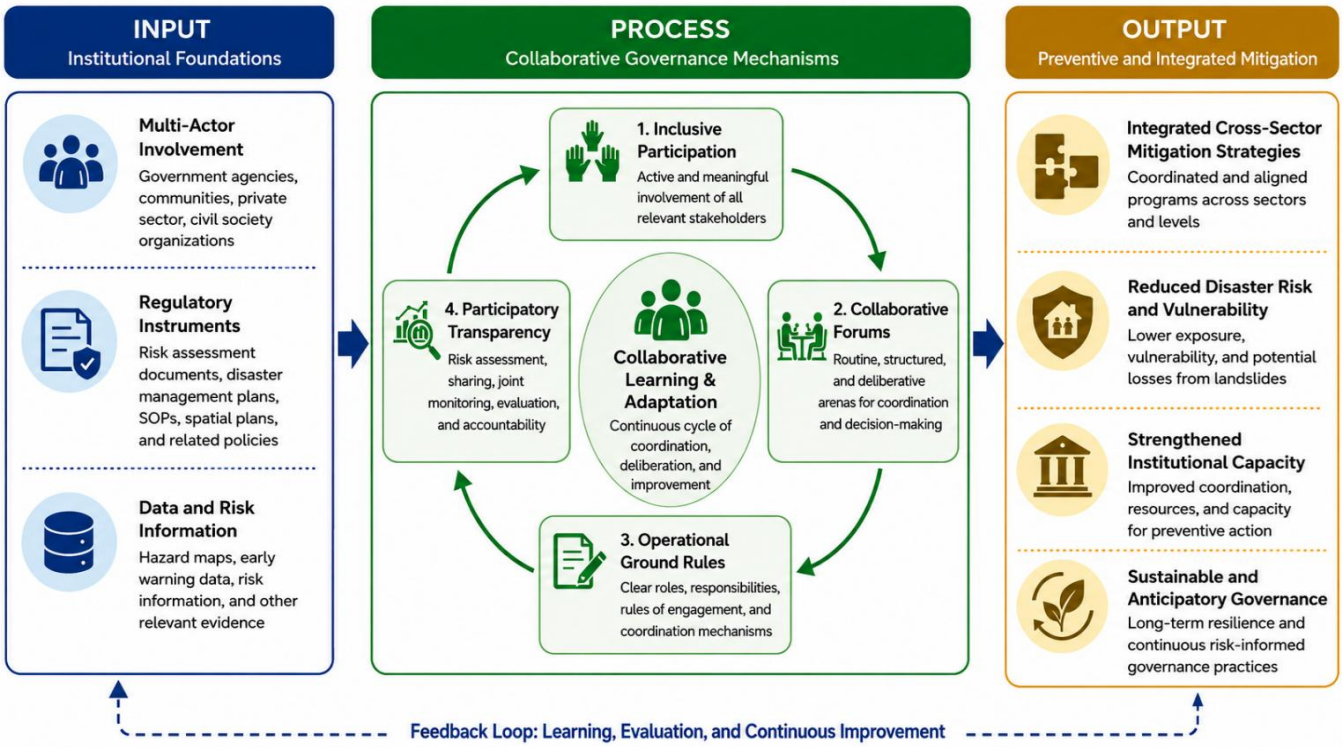

Figure 2. Conceptual-operational model of risk-oriented collaborative governance for preventive landslide mitigation landslide mitigation in Sawahlunto City

The conceptual-operational model illustrates how collaboration among multiple actors can be systematically designed and institutionalized to shift disaster governance from a reactive orientation toward a preventive and risk-informed system. It integrates institutional conditions, governance processes, and expected outcomes into a coherent analytical model.

The model is structured into three interconnected dimensions: input, process, and output. First, the input dimension represents the institutional foundations that enable collaboration. These include the involvement of multiple actors, such as government agencies, communities, private sector actors, and civil society organizations, along with regulatory instruments, including disaster risk assessments, disaster management plans, and standard operating procedures. In addition, the availability of risk-related data and information forms a critical basis for evidence-based decision-making. However, as identified in the empirical findings, the presence of these inputs alone does not guarantee effective mitigation unless they are integrated into structured governance processes.

Second, the process dimension constitutes the core of the model, emphasizing four key components of collaborative governance: inclusive participation, collaborative forums, operational ground rules, and participatory transparency. These components are designed to function interdependently as a continuous governance cycle. Inclusive participation ensures that all relevant stakeholders are actively involved in decision-making processes. Collaborative forums provide structured and routine spaces for deliberation and coordination. Operational ground rules define clear roles, responsibilities, and interaction mechanisms across sectors, while participatory transparency enables joint monitoring, evaluation, and accountability. Together, these mechanisms transform fragmented interactions into an institutionalized system of collaboration.

Third, the output dimension reflects the expected outcomes of a well-functioning collaborative governance system. These

include the development of integrated cross-sector mitigation strategies, the reduction of disaster risk and vulnerability, the strengthening of institutional capacity for preventive action, and the establishment of sustainable and anticipatory governance practices. The model follows a logical flow in which inputs are activated through collaborative processes to produce preventive and integrated mitigation outcomes.

Ultimately, the proposed conceptual-operational model contributes to advancing disaster governance by demonstrating the need to shift from reactive collaboration, which is fragmented, event-driven, and response-oriented, toward designed preventive collaborative governance, where institutional arrangements are intentionally structured to support long-term risk reduction. This transition is essential in Sawahlunto, where recurring landslide hazards require not only coordination during emergencies but also sustained and integrated preventive action.

5. DISCUSSION

5.1 From reactive coordination to preventive governance

The Sawahlunto case confirms a common challenge in disaster governance: emergency coordination is often more institutionalized than preventive mitigation. This finding is consistent with collaborative disaster-management literature showing that cross-sector coordination tends to intensify during crises because urgency clarifies authority and mobilizes resources. However, such crisis-driven coordination does not automatically generate long-term resilience. For landslide safety, preventive governance must operate before slope failure occurs, before settlements are damaged, and before communities are forced into evacuation.

Theoretically, this finding supports the argument that collaborative governance should be evaluated not only by the number of actors involved but by the quality of institutional design. Sawahlunto has multiple actors, yet their interaction remains fragmented. The case therefore demonstrates that multi-actor presence is insufficient without routine forums, operational rules, and participatory transparency.

5.2 Institutional design gap in collaborative governance

The four institutional dimensions reveal different but interconnected weaknesses. Inclusive participation is limited because local and non-governmental actors are not systematically included in decision-making. Collaborative forums are weak because they exist formally but do not function routinely. Ground rules are inadequate because they regulate emergency response more clearly than preventive cross-agency work. Transparency is administrative because information is disclosed but not translated into shared understanding or accountability. These weaknesses reinforce one another. Weak forums reduce participation; unclear rules weaken coordination; and administrative transparency limits accountability.

This pattern can be described as reactive-administrative collaborative governance. It is collaborative because multiple actors are involved. It is administrative because interaction is dominated by reporting, formal coordination, and sectoral mandates. It is reactive because institutional energy increases mainly after incidents or when emergency warnings arise. The redesign challenge is to convert this arrangement into preventive-deliberative collaborative governance.

5.3 Risk-informed collaborative governance for landslide safety

Risk-oriented governance requires more than the possession of hazard maps. It requires institutional mechanisms that make risk data actionable. In Sawahlunto, hazard maps, exposed-population data, vulnerable settlements, affected-house records, and SPM indicators should be used to define priority locations, allocate agency responsibilities, determine budget needs, and monitor progress. Therefore, the proposed model places risk information at the beginning of the collaborative cycle and connects it to forums, rules, transparency, and monitoring.

The model is conceptual-operational rather than a validated predictive framework. It does not claim statistical generalization. Its value lies in translating qualitative findings into an institutional design that practitioners can use to structure preventive coordination. This revision directly narrows the original manuscript's claim while strengthening its practical relevance.

The model should therefore be read as an empirically derived conceptual-operational model. It was developed from convergence across interview themes, documentary evidence, observation, and thesis synthesis, and it was credibility-checked through triangulation and field confirmation. It was not formally validated through an expert Delphi process, stakeholder scoring, or quantitative outcome testing. This limitation is acknowledged so that the contribution is not overstated. Future research should evaluate whether the proposed indicators actually improve landslide safety outcomes after implementation.

5.4 Implementation table for preventive landslide mitigation

Table 11 responds to the practitioner gap identified by the reviewer. It specifies how the abstract model can be translated into routine institutional practice. BPBD remains the main coordinator, but its role is reframed from a single dominant implementer into a convenor of risk-based collaboration. Bappeda becomes central in integrating risk priorities into planning and budgeting. PUPR, Perkim, and DLH are positioned as technical actors whose preventive responsibilities must be defined before disasters occur. Villages and Destana become local risk-monitoring nodes rather than merely response actors. NGOs and community leaders contribute to public education, participatory monitoring, and accountability.

5.5 Proposed qualitative safety indicators

These indicators do not convert the qualitative case study into a quantitative impact evaluation. Rather, they provide a practical monitoring logic for the Sawahlunto Government (Table 12). The indicators allow institutional reform to be linked to concrete safety outcomes: fewer households left unidentified in high-risk zones, more systematic slope and drainage maintenance, broader early-warning coverage, safer evacuation routes, stronger land-use control, and more accountable mitigation planning.

Table 11. Implementation table for risk-oriented collaborative governance in preventive landslide mitigation

Component	Lead Actor	Supporting Actors	Risk Data Used	Frequency	Operational Indicator
Risk-based collaborative forum	BPBD	Bappeda, PUPR, Perkim, DLH, sub-districts, villages, Destana, NGOs	Hazard map, exposed population, affected houses, rainfall warning, SPM data	Quarterly and after major risk updates	Minimum four meetings per year; agreed list of priority landslide locations
Joint risk interpretation	BPBD and Bappeda	Technical agencies, villages, NGOs, universities	KRB map, historical landslide events, infrastructure damage, settlement exposure	Before annual planning and budgeting cycle	Risk priorities integrated into RKPD, Renja OPD, and village planning
Cross-agency operational rules	City Secretary / BPBD	PUPR, Perkim, DLH, Bappeda, sub-districts	Role matrix, hazard zones, spatial planning documents	Reviewed annually	Written SOP for pre-disaster coordination; clear division of non-structural and structural mitigation tasks
Community-based risk monitoring	Village government and Destana	BPBD, sub-districts, community leaders, volunteers	Local slope observations, drainage condition, vulnerable households	Monthly during rainy season; quarterly otherwise	Updated village risk log; community reports submitted to BPBD
Spatial control and development monitoring	PUPR / spatial planning unit	BPBD, DLH, village governments	High-risk zones, land-use map, building locations	Every permit review and field inspection	No new unsafe construction in identified high-risk zones without mitigation requirements
Participatory transparency	BPBD and village governments	Bappeda, NGOs, community representatives	Mitigation budget, program progress, risk maps	Every semester	Publicly understandable risk and budget information; community feedback recorded
Collaborative monitoring and evaluation	BPBD and Bappeda	All forum members	SPM indicators, completed mitigation works, incident records	Semi-annually	Mitigation progress report; reduction of unresolved high-risk points; lessons learned used for next plan

Table 12. Qualitative safety indicators for preventive landslide mitigation in Sawahlunto City

Safety Dimension	Qualitative Safety Indicator	Expected Improvement for Sawahlunto
Household exposure	High-risk households are identified, categorized, and discussed in the risk forum	Clearer prioritization of exposed households for mitigation, preparedness, rehabilitation, or relocation consideration
Slope stabilization	Priority slopes are mapped, budgeted, and monitored by technical agencies	Structural mitigation becomes preventive rather than incident-driven
Drainage and slope-water control	Drainage channels in landslide-prone settlements are inspected before and during the rainy season	Reduced risk of slope saturation and small slips triggered by blocked drainage
Early warning coverage	Communities in priority zones receive warning protocols, contact chains, and rainfall-alert information	Warning information reaches exposed households before slope failure occurs
Evacuation-route safety	Evacuation routes and access roads are periodically inspected and maintained	Safer mobility for residents, especially elderly people, children, and persons with disabilities
Land-use control	Development proposals in high-risk zones are reviewed through risk data and spatial-planning rules	Reduced unsafe construction and lower future exposure
Community risk reporting	Destana and village actors maintain local risk logs and report cracks, blocked drainage, or small slips	Local knowledge becomes a formal input to preventive mitigation
Response readiness	Roles of BPBD, villages, volunteers, and technical agencies are predefined before emergencies	Shorter coordination delay and clearer division of tasks during events
Participatory accountability	Mitigation priorities, budgets, and progress are publicly explained in accessible language	Communities can monitor whether risk-reduction commitments are implemented

5.6 Implications for disaster risk management and landslide safety

The article contributes to safety and security engineering by linking institutional design with landslide safety. Engineering measures such as drainage, slope protection, and settlement control require governance mechanisms that prioritize high-risk zones and sustain implementation. Without such mechanisms, technical mitigation remains fragmented. The article also contributes to disaster-risk reduction by showing how risk-informed planning can be operationalized through collaborative governance. For urban safety planning, the model can be used to connect hazard maps with settlement planning, road-corridor protection, and community preparedness. For land-use control, it helps ensure that high-risk zones are discussed before permits, housing rehabilitation, or infrastructure investments are approved. For infrastructure protection, it clarifies the role of technical agencies in slope stabilisation, drainage maintenance, and road-slope monitoring. For early warning, it positions villages, Destana, and community leaders as information relays that translate rainfall alerts and visible slope signs into household-level

preparedness. For emergency preparedness, it predefines roles so that response time is not delayed by unclear authority during a landslide event. Finally, it contributes to urban resilience by identifying the institutional conditions needed to shift from response-oriented disaster management toward preventive, anticipatory, and accountable mitigation.

6. CONCLUSIONS

This study examined the institutional design of collaborative governance in preventive landslide mitigation in Sawahlunto City. The findings show that Sawahlunto has formal disaster institutions, risk documents, community-based initiatives, and multiple actors, but collaboration remains reactive-administrative. The strongest institutional routines are found in emergency response, while preventive mitigation is constrained by unequal participation, inactive forums, normative ground rules, and administrative transparency.

The revised analysis shows that the main issue is not the absence of actors or risk data, but the weak institutional pathway through which risk information becomes collective decision-making. Hazard maps, exposure data, affected-house records, and SPM indicators are available, but they are not yet routinely used in cross-sector forums to determine mitigation priorities, agency responsibilities, budgets, and monitoring indicators.

The article therefore proposes a conceptual-operational model of risk-oriented collaborative governance. The model emphasizes four institutional shifts: from procedural participation to inclusive decision-making; from formal but inactive forums to routine risk-based forums; from general rules to binding pre-disaster operational rules; and from administrative transparency to participatory accountability. The accompanying implementation table specifies who does what, which data should be used, how often coordination should occur, and what indicators can be monitored.

Theoretically, the study advances collaborative governance by treating institutional design as the mechanism that connects risk knowledge with preventive action. It also shows that path dependency helps explain why local disaster governance continues to reproduce emergency-response routines despite policy commitments to risk reduction.

Practically, the findings provide operational recommendations primarily for Sawahlunto City. The model may offer lessons for other landslide-prone municipalities, but it should not be treated as a universal model for all high-risk urban contexts without comparative testing, stakeholder validation, and longitudinal evaluation of safety outcomes.

This study has limitations. It is based on a single case and uses qualitative data. Future research should test the model comparatively across disaster-prone cities, evaluate the effectiveness of implementation indicators, and examine how risk-based forums influence actual reductions in exposure and vulnerability over time.

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