



Collaborative Governance in Strengthening the Early Warning System (EWS) and the Impact of Floods on Communities in Special Areas of Jakarta

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Abstract

Background: Flooding remains a recurring hydrometeorological disaster in Jakarta, causing significant social, economic, and environmental impacts. Strengthening flood early warning systems (EWS) requires technological infrastructure and effective stakeholder collaboration.

Objective: This study examines collaborative governance in strengthening flood EWS and proposes a collaborative model to mitigate flood impacts on communities.

Methods: A descriptive qualitative approach was employed through in-depth interviews, observations, and document analysis. Data were analyzed using an interactive model supported by NVivo 15. Informants represented government agencies, BPBD, BMKG, the Water Resources Agency, communities, volunteers, the private sector, and academia.

Results: Institutional Design emerged as the strongest dimension, supported by regulations, standard operating procedures, task allocation, coordination mechanisms, memoranda of understanding, command structures, and information dissemination. Conversely, Starting Conditions represented the weakest dimension due to resource disparities, capacity limitations, misaligned incentives, and insufficient operational trust among stakeholders. Although Jakarta possesses EWS infrastructure, including sensors, geospatial dashboards, command centers, and flood information applications, data integration and utilization remain suboptimal.

Conclusion: This study proposes a Digital Collaborative Governance model encompassing data interoperability, evidence-based collaborative decision-making, adaptive collaborative learning, and enabling factors. The model emphasizes digital technology as collaborative infrastructure supporting an integrated, adaptive, data-driven flood EWS to strengthen community resilience.

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INTRODUCTION

Flooding remains a recurring urban disaster concern in Jakarta because low-lying settlements, drainage constraints, dense development, and interconnected river systems expose communities to multiple, interacting risks (Kurniawan, 2024; Mathewson, 2018; Mozin S. Y et al., 2025; Sarjito & Pantja Djati, 2025; Setiadi et al., 2020). The effectiveness of flood early warning depends on more than monitoring instruments: warning information must be interpreted, exchanged across institutions, communicated to at-risk residents, and translated into timely action (Hammood, 2021; Kreibich et al., 2021; Rana, 2021; Perera, 2019; Perera et al., 2019; Ringo et al., 2024). The collaborative governance framework identifies starting conditions, institutional design, facilitative leadership, and collaborative processes as interdependent factors influencing

multi-actor decision-making (Ansell & Gash, 2008). Recent research on Jakarta and other Indonesian cities emphasizes cross-sectoral flood management, yet does not fully explain how interoperable warning information is transformed into shared operational decisions (Agustina et al., 2024; Guo et al., 2021; Henriksen et al., 2018; Holilah, 2026; Mulyaningsih, 2026; Tran et al., 2026). The present study therefore examines information governance and collective response rather than treating the mere presence of digital devices as evidence of EWS performance.

This study examines how the four dimensions of collaborative governance shape flood early warning management in Jakarta and develops a context-specific conceptual extension. Its contribution lies in the proposed connection between interorganizational collaboration and four digital governance requirements: data interoperability, evidence-based joint decision-making, adaptive collective learning, and enabling capacities. Unlike accounts that primarily describe interagency coordination, this extension specifies how data exchange and joint interpretation may link collaborative processes to warning dissemination and community response. NVivo 15 supports the organization and retrieval of qualitative materials; its use does not, in itself, constitute a claim of methodological novelty. The study offers a framework for identifying collaboration bottlenecks and considering improvements in warning governance without claiming that the proposed model has been experimentally validated.

The manuscript's preliminary compilation of flood events in Jakarta from 2023 to 2025 describes changes in the locations and types of reported inundation, including riverine and coastal flooding. Table 1 summarizes these contextual observations. Because the corresponding event-level records from the *Badan Penanggulangan Bencana Daerah* (BPBD; Regional Disaster Management Agency) of the Special Capital Region of Jakarta were not provided with the manuscript, the reported counts and year-to-year comparisons should be regarded as descriptive figures awaiting verification against primary sources rather than as independently validated statistics (DIBI, 2025).

Table 1
Resume of Flood Events and Disaster Dynamics in Jakarta 2023–2025

Year	Main Location of Inundation / Flood	Distribution of Affected Areas / RTs	Key Characteristics & Collaboration Issues
2023	South Jakarta, East Jakarta (Ciliwung & Cipinang Banks)	24–45 Submerged RT	Upstream & local extreme rains; coordination of BPBD, Natural Resources Office, and Fire Department (Gulkarmat).
2024	North Jakarta & West Jakarta (Coastal & Lowland Areas)	Generic (< 1% RT), Coastal Rob Puddle	tidal dynamics; integration of BMKG predictions and BPBD digital channels.
2025	North Coast of Jakarta (Marunda, Pluit, Kalibaru, Tanjung Priok)	23 RT & 2 Main Road Sections	The phenomenon of maximum sea tide (Perigee); the need to strengthen coastal community-based mitigation systems.

Source: Manuscript compilation attributed to BPBD DKI Jakarta (2025) and DIBI (2025); original event records and precise dataset identifiers were not provided and require verification.

Ansell & Gash (2008) define collaborative governance as a governing arrangement in which one or more public agencies directly engage nonstate stakeholders in a formal, consensus-oriented, and deliberative collective decision-making process aimed at formulating or implementing public policy. Their model comprises four principal dimensions. Starting conditions encompass power and resource imbalances (power asymmetry), incentives to participate in collaboration, and the history of cooperation or conflict among stakeholders. Institutional design concerns the formal rules governing collaboration, procedural

clarity, inclusivity of participation, and process transparency. Facilitative leadership involves guiding stakeholders, building trust, mediating conflicts, and sustaining participants' commitment. The collaborative process consists of a dynamic cycle involving face-to-face dialogue, trust building, commitment to the process, shared understanding, and the achievement of intermediate outcomes or small wins (Ansell & Gash, 2008).

METHOD

This descriptive qualitative study examined collaborative governance in Jakarta's flood early warning arrangements. The unit of analysis was cooperation among government institutions, technical agencies, community representatives, volunteers, private-sector actors, and academics. The manuscript described in-depth interviews, observations, and reviews of policy documents, institutional reports, and relevant public information as data sources. Stakeholder categories included BPBD, the Water Resources Agency, BMKG, local communities, and other nongovernmental actors. The original research account did not specify the number of informants, recruitment or purposive sampling procedures, eligibility criteria, interview dates and locations, or the duration of fieldwork. These details must be supplied from the authors' actual study records before publication. The submitted materials likewise did not establish how informed consent, confidentiality, and ethical oversight or exemption were managed; no approval or consent procedure was inferred. Source triangulation was reported as a credibility measure (Creswell & Creswell, 2017).

The analysis organized interview data, field observations, and documents in NVivo 15 using open coding, thematic grouping, matrix comparisons, word-frequency queries, and visual mapping. The four dimensions of Ansell & Gash (2008) provided an *a priori* interpretive structure, while emergent information governance issues informed the proposed extension. This approach was best described as a combination of deductive and inductive analytic logic. Themes were interpreted through comparisons across source types rather than through word counts alone. The available manuscript did not identify individual coders, an independent coding check, procedures for adjudicating disagreements, or an audit trail linking specific quotations to codes. These procedures could not be asserted without supporting research records. The terms "stronger" and "weaker" dimensions referred to the qualitative balance of described institutional supports and barriers, not to a numerical scale or a validated ranking across dimensions. NVivo facilitated the organization of interpretations but did not automatically verify them (Hartono Hartono et al., 2025).

RESULTS AND DISCUSSION

Results

Starting Conditions

The starting conditions reveal substantial barriers despite the existence of monitoring infrastructure and institutional support. The reported themes include unequal access to resources and technical capabilities, differing organizational incentives, reliance on a limited number of agencies, and insufficient operational trust. These patterns suggest that technological access alone does not ensure readiness for collaborative warning decisions. The evidence available in this manuscript consists of the authors' thematic account; anonymized interview excerpts, observation dates, and document identifiers were not provided for direct quotation or independent source tracing. Accordingly, these findings represent qualitative interpretations rather than estimates of the prevalence of individual barriers.

Institutional Design

Institutional design appears comparatively well established in the reported material, as regulations, standard operating procedures (SOPs), assigned responsibilities, coordination mechanisms, memoranda of understanding, command structures, and warning dissemination channels are described. This comparison concerns the visibility of formal mechanisms in the analyzed themes; it is not based on numerical scores for individual dimensions. The persistence of fragmented information sharing and uneven participation indicates a gap between formal coordination and the joint use of data for warning decisions. Specific document titles and

participant excerpts should be linked to these institutional claims when the study's audit trail becomes available.

Facilitative Leadership

Facilitative leadership plays an important role in providing opportunities for dialogue, mediating differences in interests, facilitating input from nongovernmental actors, building trust, and sustaining collaborative commitments. Within the facilitative leadership dimension, the Regional Disaster Management Agency (*Badan Penanggulangan Bencana Daerah*, BPBD) serves as the primary coordinator and has encouraged cooperation with the Natural Resources Office, the Meteorology, Climatology, and Geophysics Agency (*Badan Meteorologi, Klimatologi, dan Geofisika*, BMKG), and other stakeholders. Leadership also demonstrates an orientation toward innovation through the development of sensors, CCTV integration, AI-based smart technologies, and information platforms. However, leadership remains relatively bureaucratic, and collaborative forums are still dominated by government actors. Mediation capabilities, data processing, and the integration of interests across stakeholder groups require further strengthening. The study recommends a shift from command-oriented leadership toward facilitative collaborative leadership that emphasizes consensus building, conflict mediation, knowledge integration, and the empowerment of nongovernmental actors.

Collaborative Process

Within the collaborative process dimension, collaboration has resulted in the integration of hydrological sensors, the development of spatial information platforms, the dissemination of information through SMS broadcasts, WhatsApp, and social media, the integration of CCTV systems, and the preparation of SOPs and contingency plans. However, the collaborative process remains more focused on coordination than on collective learning. Data from various sources have not been fully processed jointly to generate predictive early warnings. Consequently, the system remains closer to a monitoring system than to a predictive warning system.

The NVivo analysis also indicates that collaborative processes are becoming increasingly digital. Sensor technology, information exchange, system integration, trust, community participation, collaborative forums, decision-making mechanisms, and evaluation emerge as important elements. Communities are positioned not only as recipients of warnings but also as potential sources of field information, reporters of flood conditions, users of technology, and participants in response activities. The collaborative process demonstrates the interconnections among dialogue, information exchange, coordination, sensor technology, community participation, decision-making, and evaluation.

The word frequency query conducted in NVivo 15 for collaborative governance shows the prominence of terms related to collaboration, processes, models, integration, systems, sensors, and governance. These findings suggest that the collaborative process within Jakarta's EWS is beginning to evolve into a digital, integrated, data-driven, and adaptive process.



Figure 1. Word Frequency Query_Collaborative Governance
Source: NVIVO Data Processing Results 15, 2026

The NVivo 15 word frequency visualization displays prominent terms such as *kolaborasi* (collaboration), *collaborative*, *sistem* (system), *Jakarta*, *sensor*, and *integrasi* (integration). These frequencies indicate recurring vocabulary in the analyzed textual materials; they do not, by themselves, demonstrate conceptual proximity, causal relationships, stakeholder agreement, or the strength of a governance mechanism. Interpretations concerning data integration, collective decision-making, and community response are therefore grounded in the narrative thematic synthesis reported in the Results section rather than inferred from word size or proximity in the word cloud.

Collaborative Governance Model

The extended Digital Collaborative Governance model was developed by interpretively connecting recurring qualitative themes to the four dimensions of (Ansell & Gash, 2008). Barriers associated with fragmented information were linked to data interoperability; coordination and evidence use were linked to collaborative decision-making; the need for evaluation and feedback was linked to adaptive collaborative learning; and differences in technical capacity, participation, and trust were linked to enabling factors. These relationships constitute a conceptual synthesis of the themes reported in the manuscript rather than a statistically tested model. The thematic mapping below documents the inferential steps while distinguishing manuscript-level thematic evidence from primary quotations that were not available for verification.

1. Data interoperability, defined as the ability of different systems to access, exchange, integrate, and use data coherently.
2. Evidence-based collaborative decision-making, defined as collaborative decision-making informed by verifiable evidence, data, information, and analysis.
3. Adaptive collaborative learning, defined as a shift from reactive collaboration toward a continuous learning cycle before, during, and after a disaster.
4. Enabling factors, defined as supporting conditions that include technology, human resource capacity, a collaborative culture, public participation, and adaptive evaluation.

Table 2*Interpretive mapping from reported themes to the proposed Digital Collaborative Governance model*

Reported theme	Available manuscript-level evidence	Proposed model component
Fragmented data across agencies	Thematic accounts of sensors, dashboards, and limited cross-agency integration	Data interoperability
Coordination without joint interpretation	Institutional rules exist but collective warning decisions remain constrained	Evidence-based collaborative decisions
Limited learning and feedback	Collaborative activities emphasize coordination over collective evaluation	Adaptive collaborative learning
Unequal capacity and participation	Resource gaps, uneven engagement, and operational trust barriers	Enabling factors

The proposed model extends the collaborative governance framework of Ansell & Gash (2008) by explicitly addressing the governance of digital warning information. Its four proposed components are the interoperability of agency data, the joint interpretation of verifiable evidence, feedback-based collaborative learning, and enabling conditions such as staffing, technical capacity, trust, and inclusive public participation. The model is intended as an interpretive framework for examining how institutions could jointly transform monitoring information into actionable warnings. It does not establish that the proposed relationships have been validated as causal effects.

The development of this model is based on the finding that the Special Region of Jakarta already has relatively advanced technological infrastructure, including water-level sensors, command centers, CCTV systems, geospatial dashboards, and various supporting applications. However, the availability of these technologies has not yet translated into a fully effective EWS because challenges remain in institutional coordination, data integration, collaborative leadership, and stakeholder participation. Thus, the central challenge lies not only in technological limitations but also in the need to strengthen collaborative governance to transform technological capabilities into a shared decision-making system.

The proposed framework connects starting conditions, institutional design, facilitative leadership, and collaborative processes with the practical challenge of exchanging and interpreting flood information. Data interoperability is treated as a prerequisite for cross-agency use of monitoring results, whereas evidence-based collaborative decision-making requires common procedures for assessing information and communicating warnings. Adaptive learning emphasizes feedback following flood events, while enabling factors concern personnel, participation, trust, and sustained technical support. These are proposed governance mechanisms rather than measured outcomes. Artificial intelligence and predictive analytics may be evaluated in subsequent development work, but the present qualitative evidence does not establish their performance, suitability, or validity as components of the model. The anticipated improvements in response, trust, and resilience are conceptual expectations that should be tested in future research.

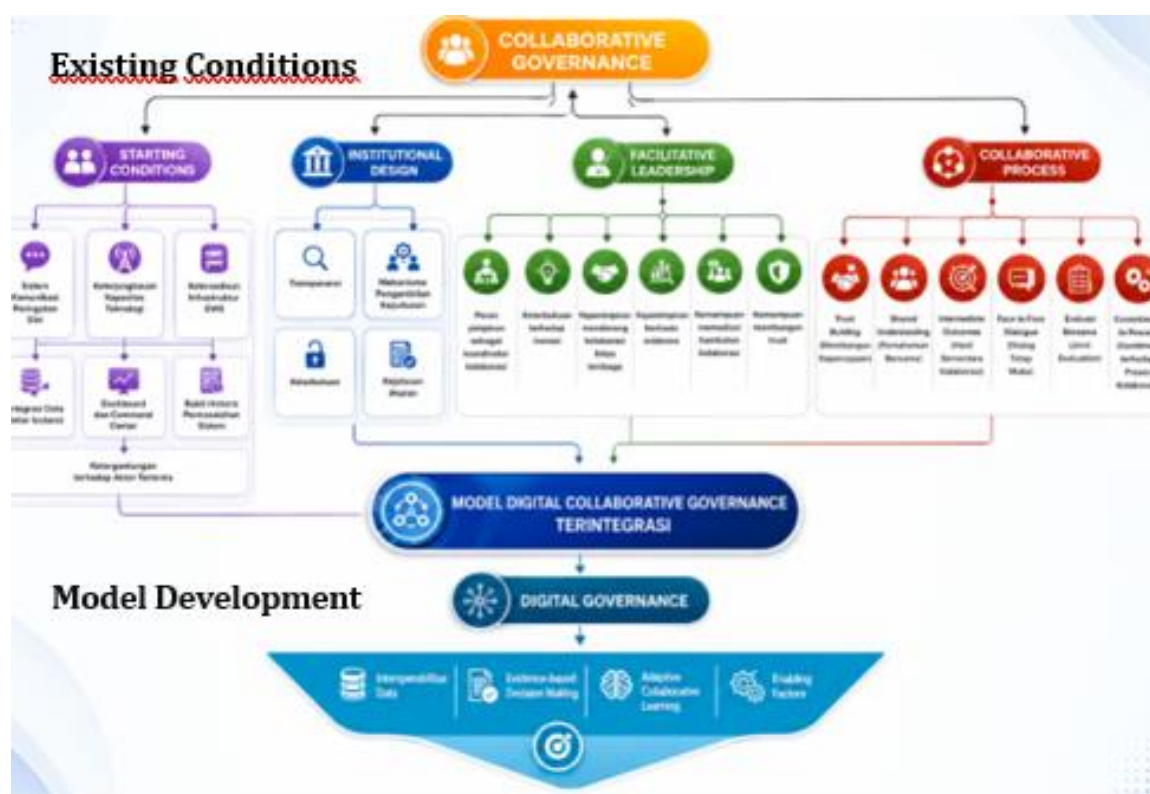


Figure 2. Collaborative Governance Model

Source: Processed Researcher, 2026

Discussion

The findings refine the framework of Ansell & Gash (2008) by illustrating why established institutional rules may coexist with weak starting conditions for cooperation in a data-intensive disaster management setting. Formal agreements and organizational mandates provide a basis for coordination but do not guarantee the shared interpretation of hydrological and meteorological information. The links between disaster risk reduction and climate adaptation in Jakarta, while Rahayu et al. (2024) examine cross-boundary complexities in Ciliwung flood governance. The present analysis complements these accounts by identifying interoperability and evidence-based interagency decision-making as specific governance tasks. In contrast to a purely technological explanation, the conceptual extension treats data as a shared resource whose institutional rules, access arrangements, and accountability mechanisms must be negotiated. This interpretation contributes a potential digital-operational mechanism to collaborative governance theory; it does not replace or empirically validate the original framework.

In practical terms, the proposed model highlights the importance of shared data definitions and protocols, clear responsibilities for data validation and warning dissemination, facilitative cross-agency forums, community reporting channels, and routine joint reviews following warning events. This emphasis is consistent with Indonesian flood governance discussions that highlight interactor cooperation, while extending the discussion to how warnings are collectively produced from dispersed information (Ernawati et al., 2024). The analysis is limited by the absence of a documented interview sample, auditable quotations, precise provenance information for event data, and systematic evidence of operational EWS performance in the submitted manuscript. Future studies should examine actual warning workflows, compare agencies and neighborhoods, test whether the four proposed components improve warning timeliness and public response, and separately assess AI-based predictive systems before recommending their adoption.

Theoretical Implications

This study contributes to collaborative governance theory by emphasizing the integration of digital technology into interinstitutional cooperation. The proposed Digital Collaborative

Governance model extends the framework of Ansell and Gash (2008) by incorporating data interoperability, evidence-based decision-making, adaptive learning, and enabling factors. This conceptual extension provides a foundation for understanding how digital governance may support collaborative disaster management.

Recommendations for Future Research

Future research should empirically examine the applicability of the proposed model across different flood-prone regions. Comparative studies involving government institutions, local communities, and technology providers could provide further insights into collaborative governance practices. Additionally, quantitative or mixed-methods approaches are recommended to evaluate the relationship between digital integration, institutional coordination, warning effectiveness, and community preparedness.

CONCLUSION

The study suggests that Jakarta's flood EWS challenges lie at the intersection of institutional coordination and the shared use of warning information. In the reported qualitative themes, formal institutional arrangements are more clearly established than the initial conditions needed for equitable and trust-based collaboration. This is a qualitative interpretation rather than a quantified performance ranking. The findings support the need to move beyond the mere availability of sensors and administrative agreements toward verifiable, inclusive, and actionable cross-agency warning processes.

The proposed Digital Collaborative Governance model extends the four dimensions of by ansel incorporating data interoperability, evidence-based collaborative decision-making, adaptive collaborative learning, and enabling factors. Its contribution is conceptual; the available manuscript does not demonstrate causal effectiveness or reductions in flood losses. Missing sampling details, participant quotations, research ethics documentation, and primary flood data records limit independent assessment. Future research should provide an auditable evidence trail, validate the model across stakeholder settings, and assess actual warning performance and community responses before drawing conclusions about implementation or impact.

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AUTHOR CONTRIBUTION STATEMENT

The first author, contributes to the development of the theoretical framework, contributes to the conceptualization of the research, validation of the methodology, interpretation of the results, and the improvement of the manuscript. The second author, the formulation of the problem, the preparation of the methodology, the collection and analysis of data, the interpretation of the research results, and the preparation of the initial draft of the manuscript. The third author contributes to data collection, data processing, validation of research results, and critical review of the manuscript. Overall, the author contributes to the results of the research, provides substantive input, revises the manuscript, approves the final version of the manuscript, and is responsible for the entire preparation of the content of the article.

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