



DISTRIBUTION OF COMMUNICATION NETWORKS ON #BANJIRSUMATERA ON SOCIAL MEDIA X

DISTRIBUSI JARINGAN KOMUNIKASI PADA #BANJIRSUMATERA DI MEDIA SOSIAL X

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ABSTRACT

This study examines the structural dynamics of digital disaster communication surrounding the #BanjirSumatera hashtag on social media X during the 2023 Sumatera flood. The research addresses the limited use of structural network analysis in crisis communication studies within non-Western contexts. Using a quantitative relational design, the study applies Social Network Analysis to map actor interactions, centrality, modularity, and clustering patterns. Data were collected through the Twitter API during the peak crisis period and analyzed using centrality and community detection metrics. Findings reveal a highly fragmented and decentralized network, characterized by low density (0.003), low average degree (0.704), and high modularity (0.908). A small group of central actors dominated information flow, while most users remained peripheral. Bridging actors played critical roles in connecting isolated clusters, highlighting structural challenges in crisis communication effectiveness.

Keywords: #BanjirSumatera, disaster communication, network fragmentation, social network analysis

ABSTRAK

Penelitian ini menganalisis dinamika struktural komunikasi bencana digital melalui tagar #BanjirSumatera di media sosial X selama peristiwa banjir Sumatera 2023. Studi ini menyoroti keterbatasan pendekatan analisis jaringan struktural dalam kajian komunikasi krisis di konteks non-Barat. Penelitian menggunakan desain kuantitatif relasional dengan pendekatan Social Network Analysis untuk memetakan interaksi antaraktor, sentralitas, modularitas, dan pola kluster. Data dikumpulkan melalui Twitter API pada periode puncak krisis dan dianalisis menggunakan metrik sentralitas serta deteksi komunitas. Hasil menunjukkan jaringan yang sangat terfragmentasi dan terdesentralisasi, dengan densitas rendah (0,003), rata-rata derajat rendah (0,704), dan modularitas tinggi (0,908). Sejumlah kecil aktor sentral mendominasi arus informasi, sementara mayoritas pengguna berada pada posisi perifer. Aktor penghubung berperan penting dalam menghubungkan kluster yang terpisah, sehingga menegaskan tantangan struktural dalam efektivitas komunikasi krisis.

Kata kunci: #BanjirSumatera, Komunikasi bencana, Fragmentasi jaringan, Analisis jaringan sosial

INTRODUCTION

Digital transformation denotes the comprehensive integration of digital technologies across organizational processes, resulting in fundamental changes in operational mechanisms and value delivery to customers. This transformation necessitates the adoption of new technologies, adjustments in corporate culture, and critical reassessment of business models to foster innovation and sustain competitive advantage (Azieva, 2021; Zhao, 2024). Examples in business, online shopping media used by consumers after the pandemic have all experienced an increase in usage in sequence, namely the WhatsApp application increased by 64%, social media (Instagram and Facebook) increased by 20%, official websites/marketplaces rose by 13%, and SMS or phone calls increased by 4%. This indicates that social media has strong connectivity in influencing society. This can also have an impact on other sectors (Purnomo et al., 2024).

The evolution of disaster communication in the digital era has redefined the dissemination, interpretation, and utilization of crisis-related information. In Indonesia, a country that experiences recurrent natural disasters and maintains an active social media environment, platforms such as Twitter have assumed a central role in facilitating real-time crisis communication (Erokhin & Komendantova, 2024; Ilyas & Sharifi, 2025). The ocean is one of the aquatic ecosystems that has the advantage of preserving beneficial ecosystems, serving as the final repository for all kinds of waste produced by human activities (Ayu & Anggraini, 2023).

The 2023 Sumatera flood exemplifies this dynamic, as the hashtag #BanjirSumatera served as a focal point for widespread digital participation by individuals, media organizations, government entities, and non-governmental organizations. This research confines its analysis to a single crisis episode, concentrating on Twitter-based interactions conducted in the Indonesian language. The selection of Twitter (X) is justified by its capacity for real-time and publicly accessible communication. The study specifically investigates the structural aspects of digital communication, deliberately excluding the analysis of content and sentiment.

Existing scholarship on crisis communication predominantly investigates message content or audience perception, while structural analysis of actor influence within digital networks remains limited. Such methodological approaches are particularly scarce in disaster-prone, non-Western contexts and seldom employ multi-metric social network analysis (SNA) (Abboodi & Pileggi, 2023; Jin, 2020; Upadhyay & Upadhyay, 2023). This study addresses this deficiency by posing critical questions regarding the identification of real-time influential actors, the pathways of information dissemination, and the structural attributes of the network.

Utilizing SNA, the research systematically examines not only the scale of communication but also the connectivity, centrality, and brokerage roles of various actors, thereby elucidating how structural affordances and limitations influence the effectiveness, speed, and inclusivity of crisis response. The results provide actionable knowledge for crisis management professionals, policymakers, and technology platform designers aiming to enhance digital infrastructure for disaster response.

Although Indonesia has witnessed substantial technological progress, disaster communication continues to exhibit fragmentation, a rigid hierarchical structure, and inadequate responsiveness to evolving crisis situations. Most existing studies emphasize message content, sentiment, or institutional preparedness, while largely neglecting the structural mechanisms that determine actor influence and the flow of information across digital networks. Empirical mapping of the interactions among government agencies, media organizations, citizens, automated accounts, and NGOs remains scarce, resulting in limited understanding of how these entities converge, compete, or cooperate in shaping discourse and mobilizing collective action during disasters.

This research gap is particularly acute in Global South contexts, where increases in internet access and digital literacy coexist with infrastructural constraints and varied cultural frameworks. Despite the integration of digital platforms by Indonesian disaster management agencies, evidence of their effectiveness in harnessing collective intelligence is insufficient. The absence of network-oriented analysis in the

literature limits our capacity to observe the decentralized and multi-actor characteristics of digital crisis communication, particularly on platforms such as Twitter.

Failure to analyze digital network structures can lead crisis managers to overlook critical actors, underestimate the significance of grassroots participation, and forfeit strategic opportunities for timely intervention. Practical consequences include delays in rumor control, inefficiencies in resource allocation, and increased public confusion. To address these deficiencies, this study applies social network analysis (SNA) to map the digital communication ecosystem associated with the #BanjirSumatera hashtag, quantify actor influence, and identify network properties that either facilitate or impede effective crisis response.

This research seeks to address both empirical and conceptual shortcomings by pursuing interconnected objectives. The study systematically documents Twitter activity using the #BanjirSumatera hashtag, capturing the network's topology and the intensity of interactions during the height of the crisis. This approach involves identifying every account (node) and mapping relationships such as retweets, mentions, and replies, thereby constructing a digital network that accurately reflects the real-time dynamics of crisis communication.

The study utilizes social network analysis (SNA) centrality metrics, including degree, betweenness, and eigenvector centrality, to identify actors with the greatest influence within the network. This methodology underscores the importance of structural positioning and intermediary roles, rather than relying solely on metrics such as follower count or message frequency.

Researchers systematically categorize actors according to their organizational affiliation, distinguishing among citizens, government bodies, media organizations, non-governmental organizations, and automated accounts. This classification enables detailed examination of the roles, strategies, and positions of each group in the crisis communication network. The resulting typology facilitates comprehensive mapping of participation, leadership, and the potential marginalization of both institutional and

grassroots actors within the digital discourse.

The analysis also incorporates network structural characteristics by measuring modularity and clustering coefficients. These metrics are critical for evaluating the resilience, fragmentation, and cohesion of the digital communication ecosystem during disaster events. They further enable the identification of barriers, echo chambers, and bridging structures that influence the efficiency and inclusiveness of information flow.

Collectively, these objectives provide both empirical evidence and a conceptual framework for understanding and improving digital crisis communication in Indonesia and comparable settings. The originality of this research lies in its structural mapping of influence, independent of survey data or content-focused analysis. It represents the first documented use of combined tri-metric centrality and modularity analysis in the context of the #BanjirSumatera crisis. By linking advances in network science to the governance of disaster response in the Global South, the study yields actionable recommendations for governmental and humanitarian actors on the impact of digital participants in shaping emergency discourse.

The theoretical grounding of the research integrates three frameworks: Social Network Theory (SNT), Digital Communication Theory, and Actor-Network Theory (ANT). SNT conceptualizes the digital crisis communication landscape as a network of nodes (actors) and edges (relationships), emphasizing the significance of centrality, density, and homophily in shaping information diffusion, the concentration of influence, and the emergence of network patterns that facilitate or impede collective action (Badi et al., 2021; Qin-fang et al., 2023). Granovetter's distinction between strong and weak ties is also pertinent, as weak ties enable the introduction of new information during crises, whereas strong ties enhance the rapid coordination of responses (Chen & Batjargal, 2025).

Digital Communication Theory introduces both technological and linguistic perspectives to the analysis of crisis communication. The Social Amplification of Risk Framework (SARF) elucidates how digital platforms can intensify, filter, or distort the

transmission of risk-related messages (Paek et al., 2024). Features such as informal language, culturally embedded codes, and real-time interactivity on platforms like Twitter create distinct opportunities and constraints for effective crisis messaging (Manurung et al., 2022). Furthermore, disparities in digital inclusion and technological infrastructure influence participation rates and determine which actors are able to contribute or have their perspectives represented (Baudet et al., 2023).

Actor-Network Theory (ANT), as developed by Latour and Callon, provides a critical sociomaterial approach by conceptualizing both human and non-human entities, including users, algorithms, hashtags, and automated accounts as active participants in constructing digital realities (Birat, 2025; Ramaswamy & Ozcan, 2020). ANT transcends human-centered frameworks by highlighting the interconnected agency of technical artifacts and social actors, thereby explaining the hybrid nature of agency within disaster communication infrastructures. These three theoretical frameworks collectively underpin the structural and relational analysis of digital crisis communication, where the intersection of network position, actor identity, and technological affordances influences the effectiveness and equity of disaster response.

This study investigates the case of severe flooding in Sumatra that generated extensive discourse on the X platform through the hashtag #BanjirSumatera. During the crisis period, thousands of accounts actively disseminated information, expressed opinions, shared field reports, and responded to emergency developments. The discussion extended beyond affected residents to include national media outlets, political actors, non-governmental organizations, and potentially automated accounts. Users interacted in real time through retweets, mentions, and replies, thereby constructing a complex and structurally interconnected digital communication ecosystem.

The central issue does not concern the sheer volume of communication, but rather the distribution of influence within the network. The study questions whether official institutions, such as government agencies and mainstream media, dominated

information flows or whether non-institutional actors exerted greater influence. It also evaluates whether the network structure facilitated broad and equitable information diffusion or instead produced fragmented clusters that functioned as echo chambers. The high modularity and low density identified in the findings demonstrate significant fragmentation and limited integration across communities.

Accordingly, the core problem lies in the relational configuration and distribution of influence within digital crisis communication. The study focuses not on message content, but on the network architecture that determines which actors amplify discourse, which serve as bridges between groups, and whether this structural configuration enhances or constrains the effectiveness of disaster response in Indonesia's digital sphere.

CONCEPTUAL FRAMEWORK

Actor-Network Theory (Latour, Callon)

Actor-Network Theory (ANT), as developed by Latour and Callon, provides a critical sociomaterial approach by conceptualizing both human and non-human entities, including users, algorithms, hashtags, and automated accounts as active participants in constructing digital realities (Birat, 2025; Ramaswamy & Ozcan, 2020). ANT transcends human-centered frameworks by highlighting the interconnected agency of technical artifacts and social actors, thereby explaining the hybrid nature of agency within disaster communication infrastructures. By treating all components of a network as "actants," ANT enables a symmetrical analysis in which human and non-human entities are considered integral contributors to social phenomena. Latour puts forward this idea in his work, emphasizing that reality is constructed through these networks, in which matter and meaning are intertwined (Birat, 2025).

Social Network Theory

Social Network Theory (SNT) serves as a foundation for understanding the complexity of relationships between individuals and entities within a network. This theory analyzes how these interactions influence behavior, information flow, and even

organizational effectiveness. At the core of Social Network Theory are concepts such as nodes and ties. Nodes represent individuals or entities in a network, while ties signify the relationships between them. These ties can be categorized as strong or weak, a distinction that plays a crucial role in knowledge transfer and resource sharing (Qin-fang et al., 2023). Strong ties generally signify close relationships that facilitate substantial information transfer, while weak ties provide access to new information and diverse perspectives, thereby enhancing innovation and knowledge dissemination (Chen & Batjargal, 2025). ANT emerged as a critical response to traditional sociological frameworks that often prioritize human actors and social structures, proposing a "sociology of nouns" rather than a more dynamic "sociology of verbs" (Callon, 1998) (Ramaswamy & Ozcan, 2020). By treating all components of a network as "actants," ANT enables a symmetrical analysis in which human and non-human entities are considered integral contributors to social phenomena. Latour puts forward this idea in his work, emphasizing that reality is constructed through these networks, in which matter and meaning are intertwined (Birat, 2025).

Digital Communication Theory

Digital communication encompasses various forms of communication mediated by digital devices and platforms. The Social Amplification of Risk Framework (SARF) highlights how digital media platforms have changed the way risk information is shared. As people interact with diverse sources and actors online, their perceptions and actions regarding risk are increasingly influenced by these interactions (Paek et al., 2024). Digital communication enables a dynamic flow of risk-related information, making it essential for effective public engagement and disaster preparedness. Research shows that digital platforms not only facilitate the wider dissemination of risk-related knowledge but also shape public understanding and responses to these issues.

METHOD

This research employs a quantitative methodology with a relational-structural design, excluding any experimental manipulation. The primary objective centers on mapping and analyzing inter-actor relationships within the crisis communication ecosystem on Twitter during the Sumatera flood event. This approach enables objective observation of relationship patterns, network configurations, and the distribution of influence, without altering the variables involved. The resulting data represent the organic dynamics of digital interactions throughout the crisis period (Borgatti et al., 2018).

The study applies Social Network Analysis (SNA) as its principal analytic framework, offering quantitative tools for assessing network architecture, actor positions, and individual roles in digital communication. Metrics including degree centrality, betweenness centrality, eigenvector centrality, modularity, and clustering coefficient are utilized to pinpoint influential actors, information intermediaries, and community structures within the network.

Utilizing SNA, the research systematically examines not only the scale of communication but also the connectivity, centrality, and brokerage roles of various actors, thereby elucidating how structural affordances and limitations influence the effectiveness, speed, and inclusivity of crisis response. The results provide actionable knowledge for crisis management professionals, policymakers, and technology platform designers aiming to enhance digital infrastructure for disaster response. Quantitative analysis is conducted using advanced network analysis software and packages, ensuring both the accuracy of measurement and the replicability of results.

Data are collected programmatically via the Twitter Application Programming Interface (API), employing filters for the hashtag #BanjirSumatera across the designated crisis timeframe. The dataset encompasses variables such as account identifiers (Node ID), interaction types (retweet, mention, reply), timestamps, and associated text metadata. Rigorous data cleaning and organization procedures are followed to guarantee data quality and completeness (Borgatti et al., 2018).

The study's population consists of all Twitter users engaged in #BanjirSumatera-related discussions. Sampling adopts a purposive strategy, focusing on users active within the digital ecosystem during the crisis period under review. The analysis encompasses the entire network structure generated within a predefined window, such as five to seven days, thereby capturing all communication patterns during the critical phase without reduction or randomization (Borgatti et al., 2018).

The study employed a Social Network Analysis approach within a quantitative-relational framework, conducted through several main stages (Borgatti et al., 2018). Data were extracted and cleaned using the Twitter API with the hashtag filter #BanjirSumatera during the crisis period, producing a dataset containing Node IDs, interaction types (retweets, mentions, replies), and timestamps. The researchers removed duplicates, irrelevant accounts, and structural relationship errors.

In the network construction stage, each account was defined as a node and each interaction as a directed edge, and an adjacency matrix was developed to structurally map relationships among actors. Network metrics were then calculated, including degree centrality to measure direct connectivity, betweenness centrality to identify actors bridging clusters, eigenvector centrality to assess influence based on connection quality, density to evaluate overall network connectedness, modularity to detect fragmentation and communities, and clustering coefficient to measure local cohesion. Subsequently, community detection and network visualization were conducted to identify clusters, echo chambers, and bridging actors through modularity and graph structure analysis. Finally, the quantitative findings were interpreted using Social Network Theory, Digital Communication Theory, and Actor-Network Theory (Borgatti et al., 2018).

This study employs a multi-level network analytical framework to examine the structure and dynamics of digital disaster communication. At the micro level, the analysis evaluates the structural positions of individual accounts using centrality measures, thereby identifying dominant actors such as Langit Senayan and bitvofficial and assessing their influence within the network. At the meso level, the study

investigates community formations and cluster configurations through modularity and patterns of local cohesion, enabling the identification of echo chambers and sub-network structures that shape internal information circulation. At the macro level, the research assesses the overall architecture of the network by measuring density, average degree, diameter, and path length, which collectively reveal the decentralized and fragmented characteristics of the communication system. By integrating these three analytical levels, the study systematically explains the distribution of influence, the structural fragmentation of the network, and the dynamics of information diffusion in digital disaster communication (Borgatti et al., 2018).

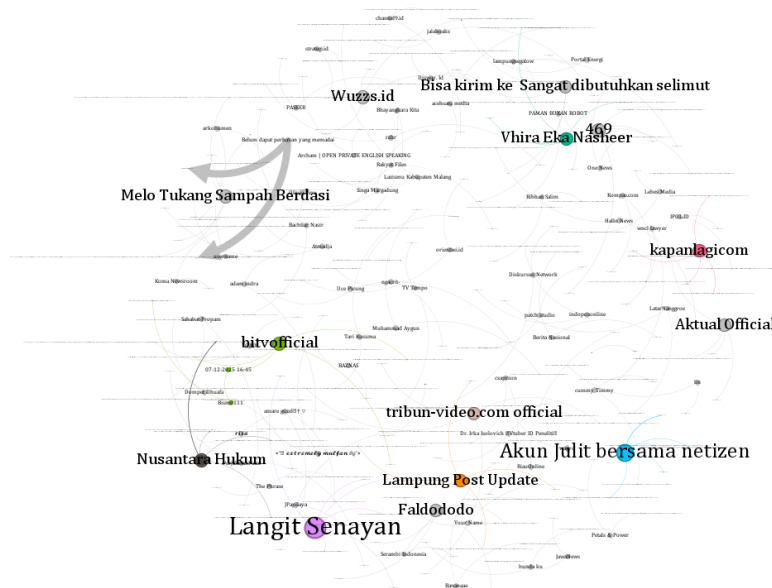
FINDING AND DISCUSSION

The evolution of disaster communication in the digital era has redefined the dissemination, interpretation, and utilization of crisis-related information. In Indonesia, a country that experiences recurrent natural disasters and maintains an active social media environment, platforms such as Twitter have assumed a central role in facilitating real-time crisis communication. The 2023 Sumatera flood exemplifies this dynamic, as the hashtag #BanjirSumatera served as a focal point for widespread digital participation by individuals, media organizations, government entities, and non-governmental organizations. This research confines its analysis to a single crisis episode, concentrating on Twitter-based interactions conducted in the Indonesian language. The selection of Twitter (X) is justified by its capacity for real-time and publicly accessible communication. The study specifically investigates the structural aspects of digital communication, deliberately excluding the analysis of content and sentiment.

This section presents the analytical findings and interpretation of the #BanjirSumatera digital communication network on the X (Twitter) platform during the Sumatra flood crisis. The analysis examines network structure, actor centrality, and relational configurations among major stakeholders, including government institutions, media organizations, non-governmental organizations, automated accounts, and citizens. Through the systematic application of Social Network Analysis

(SNA) metrics and community detection techniques, the results provide empirical insight into patterns of influence, mechanisms of information circulation, and the actors that operate as intermediaries or bridging nodes within the crisis communication ecosystem.

Figure 1. Social Network Map of #BanjirSumatera on X



Source: SNA, 2026

Central actors such as Langit Senayan, bitvofficial, Akun Julit bersama netizen, tribun-video.com official, and Nusantara Hukum are visually prominent in the network map due to their larger labels, which reflect their high centrality and frequency of engagement. These accounts serve as primary hubs, either generating substantial volumes of content or acting as critical intermediaries in the dissemination of information throughout the network.

Distinct clustering is evident, with denser sub-networks forming around specific accounts like Langit Senayan, bitvofficial, and Akun Julit bersama netizen. This structural pattern illustrates the network's high modularity, where actors within the same cluster demonstrate stronger interconnections. Consequently, discourse often remains confined within these closed communities or echo chambers, with information predominantly recirculating internally rather than bridging across

different clusters.

Certain accounts, including *tribun-video.com* official and *Lampung Post Update*, occupy strategic positions at the intersection of multiple clusters. Their placement identifies them as potential information brokers or bridges, facilitating communication between otherwise disconnected groups. Such bridging roles are essential for the rapid and broad dissemination of information, particularly in crisis scenarios.

Peripheral nodes comprising smaller, sparsely connected accounts, populate the edges of the network. These users generally broadcast information infrequently or participate marginally in central discussions, thereby exerting minimal influence on the overall flow of information across the network.

Directional edges in the visualization, marked by arrows, indicate the directionality of interactions such as retweets and mentions. Thicker or darker arrows denote high-frequency or high-weight exchanges, typically concentrated toward central actors, reinforcing their roles as influential information sources within the network.

Clusters surrounding accounts like *kananlagicom* and *AktualOfficial* demonstrate characteristics of closed, potentially topic-specific or audience-specific discussions. This fragmentation further emphasizes the lack of integration in the network and identifies obstacles to effective message dissemination throughout the crisis communication landscape.

In summary, the network map depicts a highly decentralized and fragmented communication structure for *#BanjirSumatera*, where a few highly connected nodes serve as hubs or bridges, and most actors remain peripheral. Community clustering and echo chamber phenomena prevail, corroborating the observed high modularity and low density. Enhancing crisis communication effectiveness in such a network demands the activation of central and bridging actors to address structural fragmentation and extend the reach of critical information.

Table 1. Summary of Social Network Metrics for the #BanjirSumatera on X

Label	Score
Average Degree	0.704
Network Diameter	1
Graph Density	0.003
Modularity	0.908
Avg. Path Length	1

Source: SNA, 2026

An average degree of 0.704 demonstrates that each node in the #BanjirSumatera network, on average, maintains a connection with fewer than one other node. Such a low degree of connectivity reveals a network that is highly fragmented. The majority of accounts remain either isolated or exhibit minimal direct engagement, primarily through occasional retweets, mentions, or replies. This structural characteristic is typical in networks organized around event-specific hashtags, where reciprocal or multi-directional interactions are limited to a small core group, while most users engage as passive observers or single-message contributors.

With both the network diameter and average path length measuring 1, the analysis indicates that any two connected nodes are separated by only a single step. All accessible nodes are thus reachable directly, without intermediate connections. This configuration suggests the presence of hub-and-spoke or star-shaped substructures within the network, with limited indirect linkage. However, when viewed alongside low degree and density metrics, this also reflects that such direct connections are infrequent, and widespread interconnectivity is lacking.

A graph density of 0.003 substantiates the finding of a sparse network, with only 0.3% of all theoretically possible connections present among accounts. This extremely low density aligns with the communication patterns of ad hoc, crisis-driven Twitter networks, characterized by a predominance of one-way broadcasting and weak reciprocal interaction. Only a small subset of nodes engage intensively, while the majority remain peripherally involved.

A modularity value of 0.908, approaching the maximum possible, points to a highly segmented network with substantial community division. The #BanjirSumatera

discourse is distributed across numerous distinct subgroups eighty, in this case rather than forming a cohesive conversational space. Such high modularity signifies that participants typically interact within narrowly defined clusters, leading to the emergence of echo chambers or specialized topic communities and preventing the formation of broad, integrative dialogue across the entire network.

Collectively, these metrics define the #BanjirSumatera communication network on X as structurally decentralized, highly fragmented, and sparsely connected. The prevalence of localized clustering with weak global integration impedes efficient information dissemination, coordination, and consensus formation. In this context, the role of central or bridging actors becomes pivotal in extending the reach and effectiveness of crisis communication, while the vast majority of participants remain peripheral, exerting limited influence on the overall network dynamics.

DISCUSSION

The empirical analysis of the #BanjirSumatera social network on X (Twitter) reveals a communication environment marked by structural decentralization and considerable fragmentation. Central actors, including Langit Senayan, bitvofficial, Akun Julit bersama netizen, tribun-video.com official, and Nusantara Hukum, occupy dominant positions as indicated by their elevated centrality and consistent participation. These accounts function as principal disseminators of information or essential intermediaries, consistent with Social Network Theory (SNT), which highlights the critical role of central nodes in facilitating access to resources and governing information flows (Badi et al., 2021; Han et al., 2020).

Prominent accounts such as Langit Senayan, bitvofficial, Akun Julit bersama netizen, tribun-video.com, and Nusantara Hukum demonstrate high centrality and sustained engagement within the digital network surrounding the Sumatra flood discourse. These actors serve as primary conduits for information dissemination, enabling their narratives and opinions to circulate rapidly and exert considerable influence. Due to their network position, they play a critical role in constructing dominant framings, shaping public perceptions of causality, responsibility, and

legitimacy concerning aid responses. This dynamic creates a concentrated narrative structure in which specific framings dominate, potentially reinforcing selective biases while marginalizing alternative perspectives, including those from directly impacted individuals or smaller local organizations.

Within the framework of Social Network Theory, these central accounts function as both gatekeepers and brokers. They determine which issues receive visibility and which are excluded from the conversation. Their brokerage role allows them to bridge disparate clusters in the network, facilitating interactions among local residents, national media outlets, and policymakers. This strategic positioning enables them to mobilize public attention and resources efficiently, yet it also introduces the risk of politicizing the discourse, particularly when narratives exhibit partisan or biased tendencies.

The centralization of communicative power results in an asymmetrical flow of information, with a top-down structure that suppresses horizontal or distributed engagement. Consequently, the voices of affected communities and grassroots actors may be obscured by the dominant narratives propagated by central figures. The content disseminated often aligns more closely with the priorities and perspectives of these influential actors rather than with the lived experiences of the disaster victims, thereby producing a representational distortion in public discourse.

Furthermore, the potential dissemination of unverified information or emotionally charged framing by central actors exacerbates the risks of disinformation and affective bias. Their strategic visibility amplifies the spread of misleading content, while emotionally polarizing narratives may override rational, evidence-based interpretation. As a result, the crisis narrative becomes a contested domain driven by virality, where sensationalism supersedes factual accuracy in shaping public perception and response.

The network exhibits an average degree of 0.704 and a density of merely 0.003, reinforcing the observed fragmentation. SNT suggests that such sparse connectivity results in superficial participation or isolation for most members, which is

characteristic of event-driven online networks where only a select group sustains ongoing, multidirectional exchanges (Chen & Batjargal, 2025; Qin-fang et al., 2023). A modularity score of 0.908 and the emergence of tightly knit sub-clusters further exemplify homophily in network structure, as actors with similar interests or affiliations cluster together, producing echo chambers and constraining broader intergroup communication (Asikainen et al., 2020; Liu et al., 2022).

Bridging actors such as tribun-video.com official and Lampung Post Update are positioned at critical junctures between communities, embodying the function of weak ties as articulated by Granovetter. While less frequent, weak ties are fundamental for connecting otherwise isolated groups and facilitating the spread of new information across structural boundaries (Chen & Batjargal, 2025). The visualization of directed edges and interaction intensities highlighted by thicker arrows toward central accounts, demonstrates the consolidation of opinion leadership, a phenomenon well documented in studies of political communication and digital crisis management (Niemann-Struweg, 2020; Samalis et al., 2023).

From the perspective of Digital Communication Theory and the Social Amplification of Risk Framework (SARF), the dominance of one-way messaging with limited interactive engagement substantiates the notion that digital platforms may amplify the reach of risk-related information but simultaneously restrict its dissemination to particular clusters (Paek et al., 2024). Informal language usage, cultural markers, and the technical capacities of the platform collectively shape both who participates and how widely crisis messages are distributed (Baudet et al., 2023; Manurung et al., 2022).

Digital platforms exhibit the potential to extend the dissemination of risk-related information across broad audiences. However, the predominance of unidirectional communication characterized by content dissemination without reciprocal dialogue or meaningful public engagement constrains the flow of information to specific social groups. These groups are often already connected to the original source through social networks, algorithmic affinities, or shared

ideological orientations.

Rather than fostering equitable and participatory information exchange, this communicative structure intensifies the formation of informational silos or echo chambers. Within these closed loops, information circulates among homogeneous audiences, while structurally or digitally marginalized groups remain excluded from access to crucial risk communication.

Thus, while digitalization enhances the technical scope of information dissemination, it fails to ensure communicative justice or inclusive access. In the context of public risk, virality alone does not guarantee that critical information reaches or accurately represents vulnerable populations most in need of such knowledge.

Actor-Network Theory (ANT) further enriches this analysis by recognizing the agency of both human participants (such as influencers, institutions, and media) and non-human actants (including algorithms, hashtags, and bots) in shaping the crisis communication landscape (Birat, 2025; Ramaswamy & Ozcan, 2020). The fragmentation of the network and the pivotal role of bridging nodes illustrate how social and technical factors together determine the network's capacity to coordinate an effective disaster response.

The sustained presence of echo chambers and peripheral actors presents clear challenges for crisis communication strategies. The findings indicate that, without deliberate efforts to activate bridging nodes and connectors across clusters, information dissemination is likely to remain siloed within homogeneous groups, undermining the speed and coordination required for effective crisis management. These insights are in line with contemporary recommendations to employ multi-metric social network analysis to pinpoint strategic actors and enhance digital communication frameworks (Badi et al., 2021; Han et al., 2020).

In conclusion, the #BanjirSumatera network exemplifies the structure of digital crisis communication today: decentralized, fragmented, and dependent on a limited number of bridging and central actors to ensure information flow. The integration of

Social Network Theory, Digital Communication Theory, and Actor-Network Theory provides a robust framework for interpreting these empirical results and highlights the necessity of multidisciplinary strategies to improve crisis response capacity and foster broader public engagement in the digital sphere (Paek et al., 2024; Qin-fang et al., 2023; Ramaswamy & Ozcan, 2020).

Several actionable strategies are recommended to address these challenges. First, forming a digital crisis response team that brings together specialists in communication, information technology, mass psychology, and data science, alongside representatives from government, media, and civil society, will ensure that all facets of crisis management ranging from social network data analysis to message framing and dissemination are handled in a coordinated, expertise-driven fashion.

Second, the deployment of a real-time monitoring system utilizing Social Network Analysis (SNA) and machine learning will enhance the capacity to identify central actors, map issue diffusion, and monitor patterns of public engagement throughout the crisis. Insights derived from this analytic approach can inform timely interventions, improve message targeting, and support the identification of educational or clarification requirements across diverse digital communities.

Third, the development of community-oriented digital literacy and public participation programs focused on disaster contexts is essential. These initiatives should engage citizen groups, local communities, and informal leaders to cultivate critical awareness, reinforce information validation competencies, and encourage active involvement in disseminating crisis-related messages. Integrating interactive features and collaborative incentives into digital platforms will promote public engagement that is not only reactive but also anticipatory and enduring

CONCLUSION

This study demonstrates that digital disaster communication through #BanjirSumatera on X (Twitter) exhibits significant fragmentation and decentralization, as reflected by the low average degree (0.704), minimal network density (0.003), a diameter of 1, and exceptionally high modularity (0.908). The

majority of accounts operate at the network's periphery and contribute minimally to information dissemination, whereas a small group of central actors, such as Langit Senayan and bitvofficial, dominate the flow of crisis-related messages. The presence of closed clusters and echo chambers underscores a lack of integration between communities, often restricting information circulation to insular groups. Bridging actors occupy crucial roles in linking separate clusters and facilitating broader diffusion of crisis communication. These patterns are consistent with Social Network Theory, Digital Communication Theory, and Actor-Network Theory, all of which underscore the importance of network centrality, structural position, and the interplay between human and technological agents for effective disaster response.

Efforts to improve digital disaster communication should prioritize the systematic identification and mobilization of bridging actors to ensure that crisis messages traverse cluster boundaries and reach wider audiences. Platforms and stakeholders should promote cross-community interaction through targeted campaigns and feature enhancements that facilitate group engagement. Training for government, media, and NGO personnel must include the application of network-oriented communication strategies and sensitivity to structural dynamics. Routine use of social network analysis (SNA) is advised to support ongoing monitoring, address fragmentation, and enable timely identification of central and bridging nodes throughout disaster cycles. Furthermore, revising platform policies and design to promote digital inclusion and civic engagement will mitigate echo chamber effects and information isolation. Implementing these strategies will enhance the speed, coverage, and responsiveness of crisis communication within the evolving landscape of social media.

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