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Aims and scope

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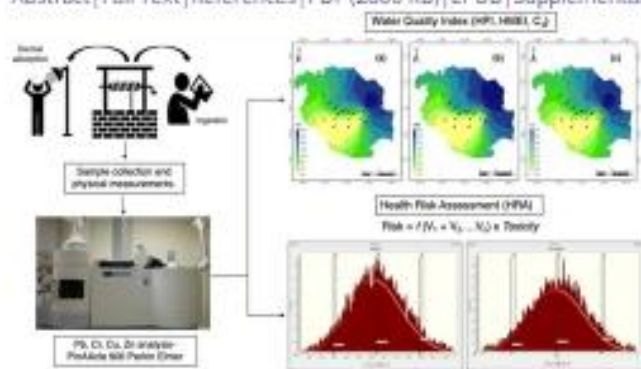
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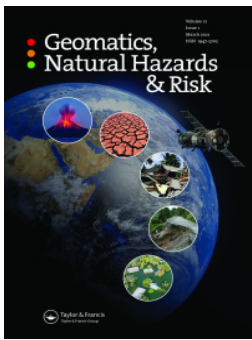
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Social networks and local communication network patterns following the destructive 2018 Lombok, Indonesia, earthquake sequence

Rachmah Ida^a, Endra Gunawan^b, Sri Widiyantoro^{b,c}, Euis Sunarti^d,
Gayatri Indah Marliyani^e and Lailatul Maulidiyah^a

^aFaculty of Social Sciences and Political Sciences, Airlangga University, Surabaya, Indonesia; ^bGlobal Geophysics Research Group, Faculty of Mining and Petroleum Engineering, Bandung Institute of Technology, Bandung, Indonesia; ^cFaculty of Engineering, Maranatha Christian University, Bandung, Indonesia; ^dFaculty of Human Ecology, Bogor Agricultural University, Bogor, Indonesia; ^eGeological Engineering Department, Faculty of Engineering, Gadjah Mada University, Yogyakarta, Indonesia

ABSTRACT

Social communication networks created during the 2018 earthquake sequence in Lombok, Indonesia using social network data from a social media platform, i.e., Facebook, and surveys in local communities were analyzed. The different modes of communication networks used during the disaster event and post-disaster mitigation were examined. Data on social media platform usage were collected from the Facebook page of the Agency for Meteorology, Climatology and Geophysics of Indonesia and the National Board for Disaster Management of Indonesia. The data show large clusters of social relation networks based on dominant issues discussed by the public under several trending hashtags. Meanwhile, the local patterns of social communication networks, particularly the flow of information and communication used by the local communities of the impacted villages in Lombok, differ depending on the culture of communication and time of accessing information. During the 2018 Lombok earthquake sequence, communication was predominantly sought from community leaders, religious leaders, family members, and neighbours. This study highlights the implementation of a decentralization system in Indonesia, which has given the local and regional authorities a significant role in disaster management, response, and emergency command for the local and regional community, instead of relying largely on the response of the central Jakarta government.

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Communication networks; social networks analysis; communication pattern; the 2018 Lombok earthquake sequence

1. Introduction

Social media, such as Facebook and Twitter, play an important role in disaster management, and they are considered to be the fourth most popular source for accessing

CONTACT Endra Gunawan  endra.gunawan@itb.ac.id

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emergency information (Lindsay 2011). A communication network is a structure that has been formed from the social communication relationships of the populace (Scott and Carrington 2011). Social relationships show how individuals from within the network build their connections and talk or communicate with one another. The social communication network is not only formed from an individual's personal contacts but also their virtual networking through the internet and social media.

Social network analysis is the process of investigating social structures using networks and graph theory sourced from social media activities (Otte and Rousseau 2002). It categorizes networked structures in terms of nodes (individual actors, people, or things within the network) and the ties, edges or links (relationship or interactions) that connect them (Grandjean 2016; Hagen et al. 2018). Therefore, in a social communication network, individuals who have more connections are called "actors". The role of an actor is significant in social networks, particularly regarding providing information on disaster mitigation, finding responders, locating donation sites, and so forth. The actor is relied on by many as a source of information, as s/he is sometimes a well-known or popular figure among the public.

As such, interpersonal communication during disaster events and post-disaster situations is a significant component of the disaster response and recovery or relief situations which affect people, families, and communities directly impacted by the disaster, as well as first responders, support systems, and other relatives. The systems of interpersonal communication and the types of information that can be trusted and can be easily and openly accessed are crucial for a community's resilience during a disaster event. However, in some cases, victims of disasters do not have social media to hand when an earthquake occurs.

Besides the use of an interpersonal or traditional system of communication by the victims of the earthquake disaster, people also tend to rely on mainstream media coverage: in particular, news reports on the television. When a disaster occurs, media coverage and the arrival of aid from other places can be used as an indicator of its severity for both the local community and other parties, such as national agencies. According to Sato et al. (2013), increased support and responses from outside disaster-affected areas are a significant cause of the spread of mainstream media coverage. Sato et al. (2018) also studied the relationship between the level of damage and the number of victims post-disaster examining the amount of media coverage broadcast during the earthquake event in Kumamoto, Japan. They found that increased and wider media coverage of a disaster led to more support and aid arriving in affected areas. They suggested that the role of news media outlets, particularly news websites, has influenced people's reactions, their support, and the response directed to the impacted disaster areas.

In comparison, people experienced fewer responses and less support in disaster-affected areas that received less media coverage, even though they may have sustained more or worse damage. Therefore, public reaction and responses to disaster victims appear to be related to the amount of information and news coverage provided by the media and news websites. There appears to be a relationship between the amount of damage, the media coverage, and the support and response directed to the places impacted by disasters. In other words, during and post-disaster events, the mass

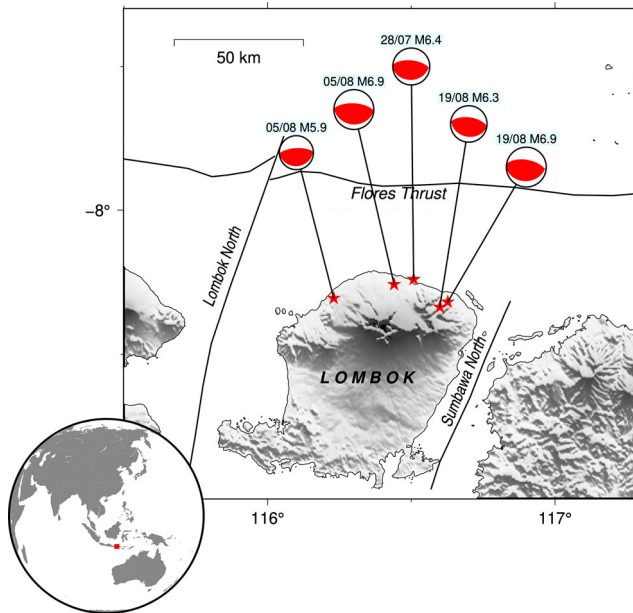


Figure 1. Location of the 2018 Lombok earthquake sequence. The moment tensor of each earthquake was taken from the United States Geological Survey database. Source: Author.

media play a role in creating topics of discussion related to the disaster and the areas impacted. Those topics, or clusters of topics, in turn, begin the formation of public social networks through social media activism to provide response and support to local communities and areas affected by disasters.

Several studies conducted in Indonesia in relation to disaster mitigation and inter-organization network analysis have covered incidences of natural disasters, such as the 2004 M_w 9.2 Sumatra-Andaman earthquake (Kusumasari 2012; Lassa 2015). Those studies, however, have not specifically focused on Indonesian earthquake incidents in recent years (Gunawan et al. 2018; Widiyantoro et al. 2020; Gunawan et al. 2020a). Thus, currently, there is a lack of academic study on social media use or communication network analysis during disaster events and post-disaster mitigation and management in Indonesia. One recent destructive earthquake was the 2018 Lombok earthquake sequence (Figure 1; Sunarti et al. 2021; Gunawan 2021). During this event, various public issues were raised and became popular topics for discussion at both local and national levels on social media platforms. Trending topics used by the public on social media platforms such as Facebook and Twitter arose through hashtags such as “#SaveLombok,” “#PrayforLombok,” and “#GempaLombok.”

This study raises research questions such as: How was the structure of social communication networks from social media platforms formed during Lombok’s earthquake disaster in 2018? Who were the actors that played significant roles in distributing and circulating information? How many clusters were formed? Did a system of interpersonal or traditional/local communication networks exist and were they utilized when the disaster occurred? What common pattern of communication was established by the victims in the disaster location?

By generating the number of social communication networks based on big data sources, this study is expected to provide descriptive data that can be utilized by policymakers in Indonesia concerning the information supply and distribution of knowledge regarding disaster management, mitigation, and relief efforts for first responders, national institutions, and the wider community. By using a combined approach of utilizing big data sources and the technique of social network sociometry, we have examined the differences of how the local community connected with the world outside and how the world outside reacted and responded to the disaster. In addition, this approach has also recognized the inter-networking between the local community and the wider society who did care about the event. The study has also used a communication network analysis (Rogers and Kincaid 1981), which was aimed at describing a picture of the local community's social network in the event of a disaster. By drawing the network, the roles and the positions of key persons and local leaders that were significantly influenced and can be utilized by the government or national body of disaster emergency to become the first contact and major decision-making for the local community have been evaluated. For traditional rural people, their local leaders are more trusted and relied upon for any action and decision-making regarding the needs of the community in their everyday social lives. Therefore, this research aimed to identify the key persons and leaders in the community for further disaster mitigation occasions and to continue the resilience scenario in the location of this research.

In our investigation, this study has looked at the social communication network maps generated during the 2018 Lombok earthquake informing public opinion and influencing societal attitudes towards the issue of natural disasters in Indonesia. The study has attempted to examine the structure of communication networks based on a social media or data mining analysis, and by interviewing local communities impacted by the earthquake to investigate the mode of social communication networks (Rogers and Kincaid 1981; Barnett et al. 1993) and how traditional patterns were applied during the evacuation and relief processes. Using news coverage from the mainstream media and online news websites, we use hashtag (*#PrayforLombok* and *#GempaLombok*) topics that dominated during the 2018 Lombok earthquake sequence from July 2018 to January 2019 as keywords to search on Facebook and to examine the formation of topic clusters, which were used as a basis to form the structure of social communication networks. The cluster of topics during the earthquake disaster in Lombok has also been analyzed.

2. Data and method

This study employs two different types of data collection: big data mining from Facebook pages and direct interviews with local community members. The first part of this paper is the analysis of how two key Facebook pages were used during the Lombok earthquake sequence. They are the official Facebook pages of the Agency for Meteorology, Climatology and Geophysics of Indonesia (BMKG; <https://www.facebook.com/InfoBMKG/>) and the National Board for Disaster Management of Indonesia (BNPB; <https://www.facebook.com/InfoBencanaBNPB/>).

Table 1. Statistical matrices of data sets.

Data sets	BMKG	BNPB
Vertices	14631	1200
Unique Edges	21017	1495
Edges With Duplicates	0	0
Total Edges	21017	1495
Number of Edge Types	3	3
Post	148	167
Commented Post	14483	1033
Replied to Comment	6386	295
Self-Loops	148	167
Reciprocated Vertex Pair Ratio	0	0
Reciprocated Edge Ratio	0	0
Connected Components	148	167
Single-Vertex Connected Components	3	83
Maximum Vertices in a Connected Component	1876	207
Maximum Edges in a Connected Component	2741	324
Maximum Geodesic Distance (Diameter)	2	2
Average Geodesic Distance	1.99049	1.93771
Graph Density	0.00097	0.00092
Modularity	0.96087	0.86418
NodeXL Version	1.0.1.412	1.0.1.412

Mickleit (2014) has suggested that in the digital age, government institutions have created web pages on social media platforms such as Facebook, Twitter and others to communicate with their communities. The Facebook page of BMKG is an official social media channel for the national agency that is the government's official body that regularly provides information and updates regarding local and national climate, weather, and geophysical conditions. It has had 952,000 followers since it was created in 2009. As such, the Facebook page of BNPB is also an official social media channel of the national disaster management body, which has been followed by 2,031,334 users since it was created in 2012. For this study, we have collected a data set from these two key Facebook pages from July 29, 2018 (one day after the first earthquake) to January 2, 2019, during post-disaster relief efforts, as suggested by the Indonesian authorities. Several earthquakes occurred in Lombok during mid-2018, measuring magnitudes between 5.9 to 6.9 (Figure 1). We collected data sets from both institutional and individual's posts, replied comments, and comments on the page during the 2018 Lombok earthquake sequence. We have also used conversation analysis and network structures that were formed from the Facebook channels of these two national bureaus. Table 1 shows summary of statistical matrices of data sets.

NodeXL is used as a tool to search, and filter issues related to the 2018 Lombok earthquake. NodeXL is an analysis tool that can help visualize a social network derived from social media data, particularly the major issues or topics discussed by social media users. This tool can also be used to visualize networks from imported computer data, which, in turn, can be used to look at the interconnectedness of social networks among social media users in relation to the issues and topics discussed (Smith et al. 2009). Smith et al. (2009) reported that the existence of social media allows for a description to be given of the formation of digital archives related to social relationships in recent years. They suggested that social media has made the digital pathways of social relations available and traceable and that social media applications enable the collective creation and sharing of digital artefacts.

NodeXL has become a tool to help visualize the prevalence of digitalized social relations in social media and related networks. It is also used to depict the formation of actors and clusters (Hansen et al. 2010), as well as to allow academics and practitioners to understand communication structures to aid decision-making. Using NodeXL, we collected data using the dominant hashtags “#PrayforLombok” and “#GempaLombok” as keywords to search for the formation of social relations and to visualize the structure of social communication networks. From the data mining results, we considered four levels of analysis: the structure of the network analysis, a cluster analysis, a factor analysis, and a conversation analysis of the Facebook users on these aforementioned pages.

The second part of this paper examines the picture of the community social network of the locals in Lombok. The quantitative data were collected directly from interviews with community members living in earthquake-affected areas located in Senggigi village of West Lombok and Genggeling village of North Lombok. These two villages were impacted heavily, and the physical damage they suffered was worse compared to other villages. We also did interviews with the officials’ representatives of the regional government bodies and agencies related to disaster management and the sub-district administration officers for supporting the secondary data. From the interviews with the village communities and key opinion leaders, we then drew models of the social relationships or interpersonal networks used by the community during the disaster and relief efforts, and future mitigation processes for their region post-disaster. To analyze the social communication network within the local community, this study used sociometric questionnaires (Rogers and Kincaid 1981) administered to the individuals or disaster victims, and asked them whom they had contacted and communicated with during the disaster. The sociometric results will show us the interpersonal network pattern and identify the opinion leader and the key person(s) who were trusted and relied upon by the local community members. Therefore, by using two different approaches, this study hopes to gain different pictures of the public responses and activism during the disaster to estimate the extent of external support and the strong role of social media in the events of the disaster, as well as to see the structure and strength of community information circulation and support distribution.

3. Result and discussion

3.1. Community communication network on social media

From the data set imported from the official Facebook pages of BMKG and BNPB, we found that the structure and formation of social networks by each government body were different. In this part, the paper will show first the pattern of social networks gathered from the BMKG’s Facebook page, and this will be followed by the BNPB. As mentioned above, BMKG is a meteorology, climatology and geophysics body that is responsible for providing information, mostly, about daily weather forecasts. This institution is more popular among the people in Indonesia than BNPB, which tends to be viewed as being responsible only for disaster mitigation and is less active in providing information compared to BMKG. The social network patterns

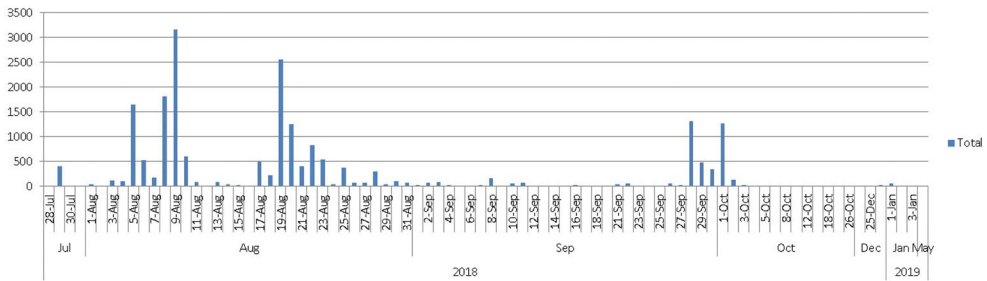


Figure 2. Timeline graph of conversations during the 2018 Lombok earthquake sequence from the BMKG Facebook page (<https://www.facebook.com/InfoBMKG/>). Source: Author.

gained from these two official Facebook pages will then be compared and contrasted, particularly with regard to the four dimensions of network aspects.

The social communication network formed on BMKG's Facebook page has shown dynamic connections, particularly during the disaster event in Lombok. The structure of social networks formed various clusters or social clicks. On every cluster, there were various nodes or vertices, and edges or lines. The vertices, also called nodes, agents, entities, or items, can represent many things. Edges, also known as links, ties, connections, and relationships, are the building blocks of a network. An edge connects two vertices. Edges can represent many different types of relationships, such as proximity, collaboration, kinship, friendship, trade partnerships, citations, investments, hyperlinking, transactions, and shared attributes (Clauset et al. 2004). The vertices represent the actors of the social network paths, while the edges represent the connections between the vertices or actors. These data represent the responses from the external publics outside of Lombok Island. People showed their sympathy and support for the disaster victims and their loss. The connections also demonstrate the closeness between the people in Lombok and the people outside, particularly the citizens of Indonesia. In other words, the feature of social network shows the closeness of socio-cultural bonding among Indonesians, reflecting Benedict Anderson's term "imagined community" (Anderson 1991).

From July 29, 2018 to January 2, 2019, there were 148 posts posted on the BMKG Facebook page. There were also over 14,000 responses to or comments on the posts, and over 6,000 replies to the comments. Interestingly, there were over 14,000 vertices found, including actors that played a major role in the social communication networks. The number of vertices in the network was 1.51% of the total followers of BMKG's Facebook page. Meanwhile, the number of edges or connections between vertices in the graphs was over 21,000, resulting from conversations and the connectedness of the public in discussing the issue of the 2018 Lombok earthquake. The comparison between vertex and edge was approximately 2:3, meaning that for every two vertices, three edges were connecting, one to another. Simply, every actor (vertex) was connected to one to two other actors (vertices) in the network.

The number of conversations occurring on the BMKG Facebook page increased dramatically on particular dates: July 29, 2018; August 5, 2018; August 9, 2018, and August 19, 2018. These dates reflected the intense conversations that took place following a series of earthquakes with high magnitudes (Figure 2). Almost two months

after the 2018 Lombok earthquakes, other large earthquake and tsunami events in Palu and Donggala, Central Sulawesi, caused widespread damage (Gunawan et al. 2020b; Natawidjaja et al. 2021). The conversations started to increase and reached a peak during the day a disaster occurred.

Unlike the social network structures formed on BMKG's Facebook, the formation of social network structures on BNPB's social media channels, which had 83,000 followers, appeared larger and less densely populated. Sourced from the Facebook page of BNPB's Public Relations team, we found the intensity of conversations during the earthquake events in Lombok were predominantly created by vertices, or actors, outside of Lombok Island.

From both graphs describing the social communication networks, four types of analysis can be.

3.1.1. The network structure analysis

A network structure analysis examines the formation of social relations and communication among social media users or actors for particular issues. From the data obtained during data mining, NodeXL can present graphs of network formations. The graphs are a complex system consisting of clusters, which are formed from similar topics or issues discussed on social media, collated using an algorithm. The algorithm used by Clauset et al. (2004) or Clauset-Newman-More (CNM) Centrality, which we employed, was clear in explaining the variety of complex systems in communication networks from the web and internet social media, which are represented by graph, vertex (tie or actor), and edge (connection or relation). The CNM-Centrality algorithm has been used in this present study to detect the community network. The CNM-Centrality algorithm has been combined with Pagerank algorithm (Boldi et al. 2005). Pagerank algorithm was used to detect the important ties, while CNM-algorithm was used to detect the community. There is a parameter in Pagerank algorithm that influences the result from the rank value, which is called a damping factor. The damping factor value has been set from 0 to 1 (Boldi et al. 2005). The highest rank value will become the most important node that will be used by CNM-Centrality algorithm to detect the community. According to Hu and Yuhua (2016), the CNM-Centrality algorithm is valued to provide the fastest running value and reliable modularity value. However, Hu and Yuhua (2016) only used the CNM-Centrality algorithm to particular major network structures. Similar to that, we only utilized the CNM algorithm to detect the Facebook data set gathered from two Facebook pages of BMKG and BNPB in selected period, in order to look at the number of ties and relations formed of the networks.

In addition, as Clauset et al. (2008) argue that social networks show hierarchical organization consisted of vertices that divide into groups that further subdivides into groups of groups and so on over multiple scales. In this present study, the groups or clusters are found to correspond to the functional unit what so-called 'communities in social network.' Taking the cue from Clauset's et al. on the formation of clusters or groups of groups, we also could see distributions of vertices into clusters, number of clustering, and short paths. Unfortunately, we did not infer hierarchical structure from network data, which often show that existence of hierarchy can explain

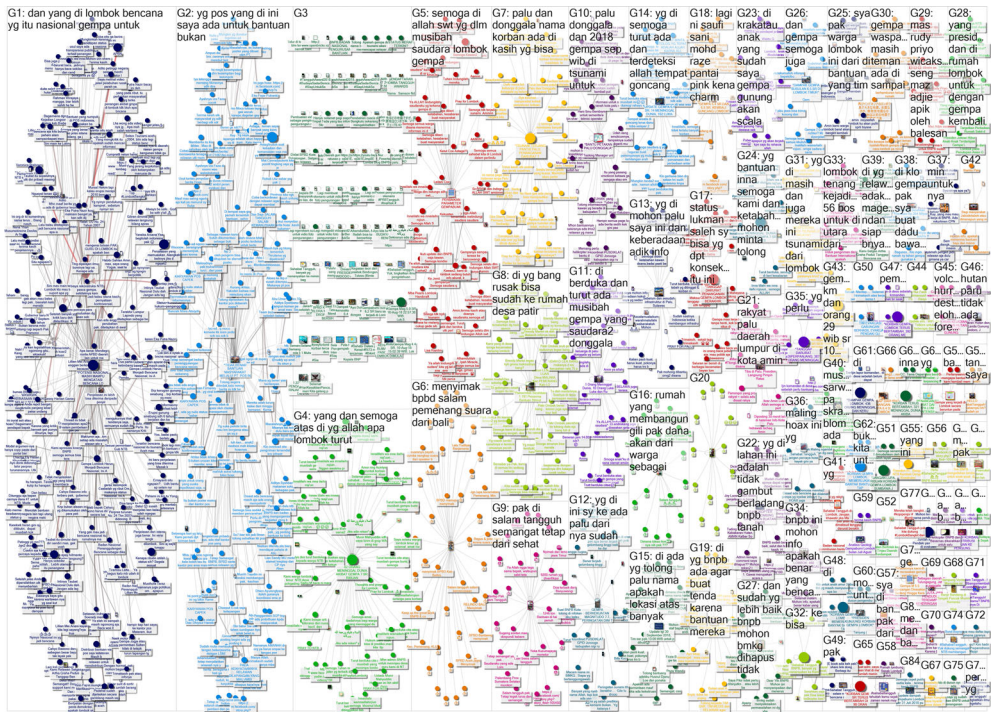


Figure 3. NodeXL graphic and social network structure on the BNPB Public Relation’s Facebook page (<https://www.facebook.com/InfoBencanaBNPB/>). Source: Author.

simultaneously and quantitatively reproduced ‘topological properties’ of networks such as “right-skewed degree distributions, high clustering coefficients, and short-path length” (Clauset et al. 2008, p. 98). Consequently, as a limitation of this present research, it does not display the hierarchical complex networks that explicitly to include organization at all scales in a simultaneous network, since one of the purposes of this research is to examine the different formation of clusters only of the external supports to the event of Lombok earthquake disaster.

The big data graph sourced from the BMKG Facebook page consists of 148 clusters, which are the same as the number of posts available on the BMKG Facebook page for six months, including those posted during the disaster and post-disaster periods. Meanwhile, the number of clusters formed from the BNPB Facebook page was greater, with 167 clusters present (Figure 3). The network structure analysis of these two social media channels suggests different formations of clusters. From the BMKG page, we can see that the formations of each cluster appear dense and complex, while from the BNPB page, the clusters appear less dense and simple. For instance, there were only 212 comments and 880 likes and reactions posted on the BNPB’s Facebook page during the same period as the communication activities on BMKG’s Facebook page. These data mean that the degree of public involvement and responses given to the earthquake incident in Lombok Island was more intense and engaged on BMKG’s page than on BNPB’s. However, the number of clusters formed on BNPB’s social media was more dynamic in terms of the variety of issues discussed by the public.

3.1.2. Cluster analysis

There were several large and small cluster formations in the network structure of the BMKG page. Large clusters indicate how more conversations and comments have been posted in response to a topic on the page. Large clusters also signify large number of responses by Facebook users. situated, starting from G1, and decreases with each following cluster. To be more detailed, the content of a post in the G1 cluster contains detailed information about the earthquake, such as its magnitude, the epicentre, and other technical geophysical data and information. This information was first posted on 9 August 2018 and received over 1,900 comments and over 5,800 likes and reactions from Facebook users. Although there were many clusters formed in the structure, with the graph density measured at 9.75, there were fewer connections between clusters. The graph density is measured by the number of edges among a group of vertices over the total possible number if everyone was connected to everyone else. A high graph density means that most people are connected to many others. A low graph density means that most people are not connected to many others (www.smrfoundation.org, accessed on July 19, 2021).

On the other hand, the number of clusters formed on BNPB's Facebook page was greater, especially in G1, than the clusters formed on BMKG's Facebook page. The number of clusters formed on BNPB's page was 167. Another indicator that can be used to measure the quality of clusters is by looking at their modularity. Modularity is a measure of the fitness of the groups that are created in a clustered network. A group is a set of vertices. Many group cluster algorithms are intended to find sets of vertices that are strongly connected and relatively separate from other strongly connected groups. Modularity is the measure of the number of edges that leave a group to connect to vertices in a different group. If the modularity is high, the clusters or groups created may be of low quality. If the modularity is low, the groups are well-defined (www.smrfoundation.org, accessed on July 19, 2021). Based on the matrix analysis provided by NodeXL, this study found that the modularity of clusters on BMKG's page was 0.960875, meaning that the cluster quality was low, and connectivity between clusters was low or non-existent.

Three large clusters (G1, G2, and G3) were formed on BMKG's page with large numbers of vertices. As mentioned above, these three clusters contained issues that had received much attention and many responses and were used as discussion topics by the Facebook members. Cluster G1, for instance, showed the attention of the public regarding the earthquake incidents and their shock when they realized that the impact of the earthquake had caused such large amounts of damage in the villages located near the popular tourist beach areas of Senggigi, and also among the people who lived in the hills of West Lombok.

Cluster G2 described conversations among the Facebook users regarding the earthquake that had taken place on the neighbouring Java Island on August 8, 2018, with users concerned that the disaster was part of the earthquake series on Lombok Island. There were 4,800 likes and reactions, and 977 comments responding to the issue of the Java Island earthquake. Facebook users appeared to warn communities on Java Island to stay safe and remain alert for incoming large magnitude earthquakes like those in Lombok. Finally, cluster G3 discussed the issue of the largest earthquake

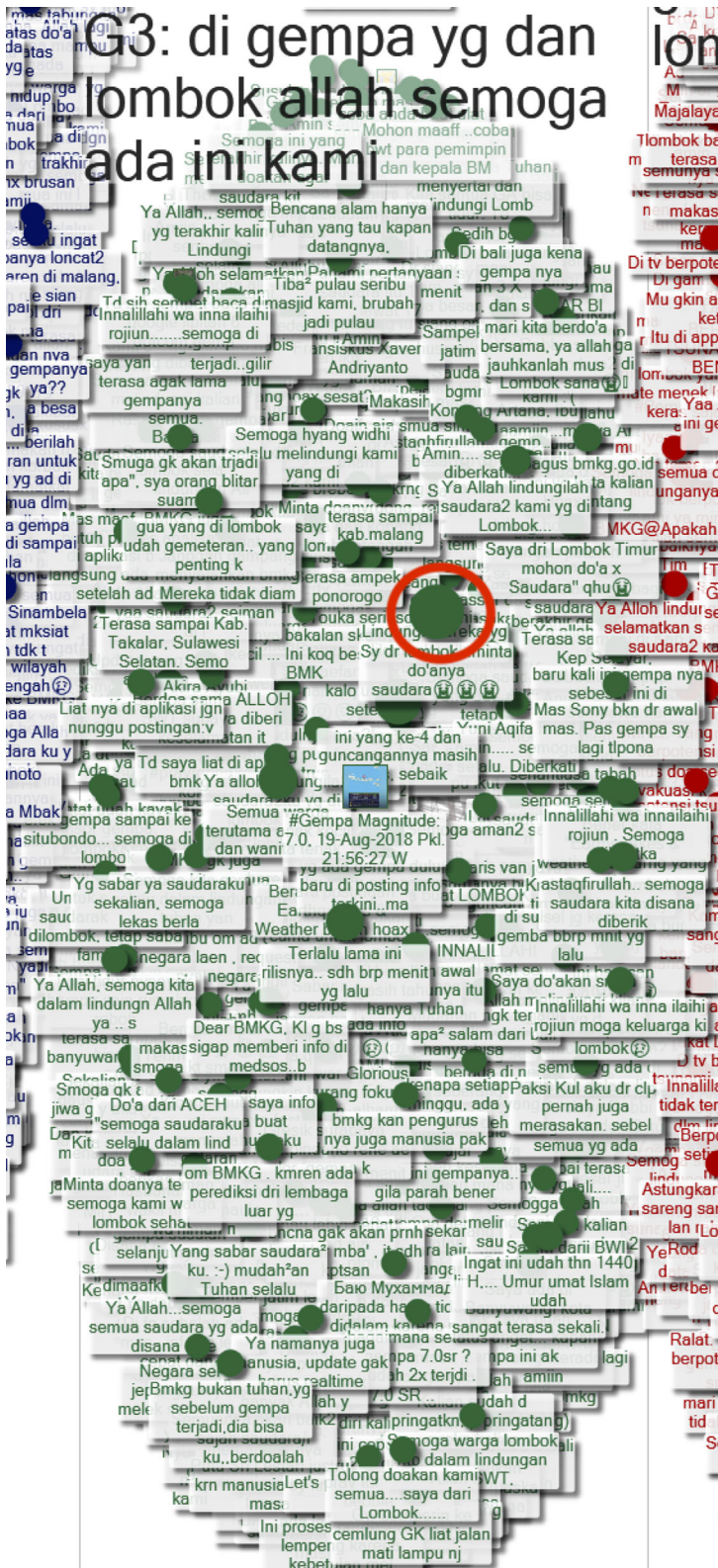


Figure 4. Dominant Actor Node of the Facebook user on Cluster G3 from BMKG's page (<https://www.facebook.com/InfoBMKG/>) as indicated by red circle. Source: Author.

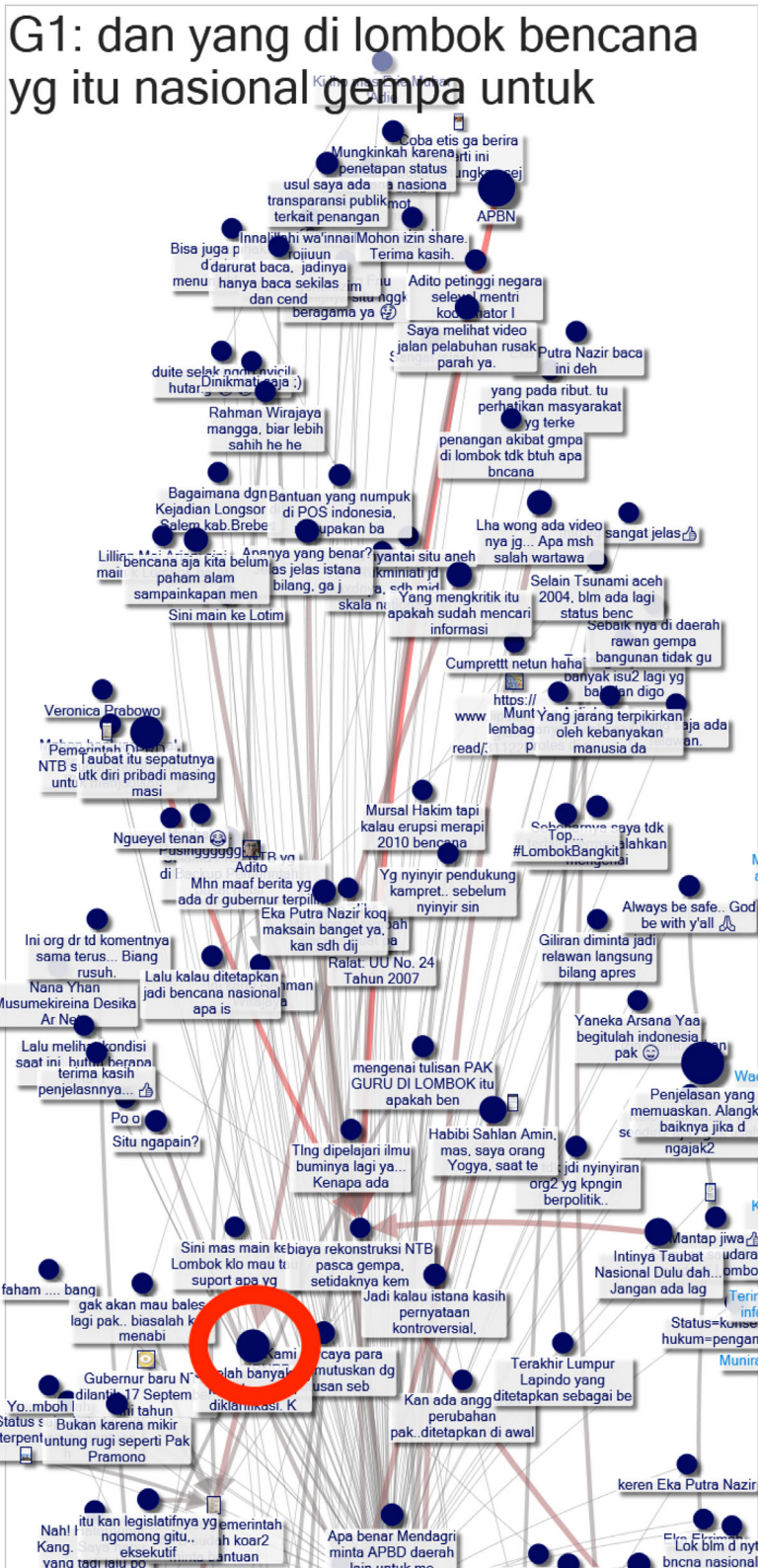


Figure 5. Dominant Actor Node of the Facebook users on Cluster G1 from BNPB's page (<https://www.facebook.com/InfoBencanaBNPB/>) as indicated by the red circle. Source: Author.

event, measuring a magnitude of 7.2, which occurred on August 19, 2018. 5,100 likes and reactions and 722 comments appeared on the BMKG Facebook page at that moment, making cluster G3 one of the largest clusters, with many responses.

From these results, it appears that social networks revealed the level of support and external/public responses to the affected victims and areas of disaster. The clusters appear to have become a group or a closed clique of Facebook users who had chosen the response and issue to be followed. According to the cluster, this study can describe the types of relationships every user had to the other users based on the issues chosen or responses made.

3.1.3. Actor analysis

In terms of the actor dimension, the analysis can be seen at the level of geodesic distance. There are two types of geodesic distance: maximum and average. Geodesic distance is a chain or path composed of edges that link two vertices, potentially through intermediate vertices. The shortest path is the minimum number of connections needed to link two vertices; the longest path is the maximum. The average length of these paths is the “average geodesic distance” (www.smrfoundation.org, accessed on 19 July 2021). The average and maximum geodesic distance were approximately two vertices, meaning that one actor was linked to two other actors.

A dominant actor in each cluster can be indicated by the size of the node circle. A larger node circle size means the actor plays a more dominant role within the network. The size of the node circle is influenced by or dependent on the number of responses, including likes, reactions, and comments, towards any post. For instance, in cluster G3 on BMKG’s page (Figure 4), one of the dominant actors to emerge was Grahita Sembrani’s post, which received 139 likes and reactions from other Facebook users.

On BNPB’s page, dominant actors were found in cluster G1 (Figure 5). There were two actors (Erwin Setiawan and Djuhdi Husnuddin) who had many connected edges, with both actors receiving the same number of likes, responses, and replied comments; yet, Djuhdi Husnuddin gained more connected edges through the number of followers compared to Erwin Setiawan. These people received more connections and networks since their posts were mostly liked and responded to by other users. However, we cannot identify the degree of social connectedness between these two and other Facebook users in general. This result is different to the results that we gained from our survey of the local people of Lombok, as discussed in the second part of the result in this paper. The actors in the community are those individuals who are respected, trusted, and relied upon most by the locals who know them well.

3.1.4. Conversation analysis of social media users

The conversation analysis was conducted using words, phrases, and hashtags used by social media users. Dominant words and hashtags were found during the data mining of the Facebook pages of BMKG and BNPB during the earthquakes in Lombok. Some popular hashtags, such as *#prayforlombok* and *#BMKG*, dominated and indicated popular topics discussed by the public in their social network. Having the largest node circle means that an actor has the largest number of edge connections, and

Table 2. Top words in comment in entire graph.

[4265]	di
[3711]	gempa
[3693]	yg
[2816]	dan
[2245]	ada

holds a more significant role within the social network. These hashtags were also used by the government and related institutions to convey accurate and real-time information regarding the earthquake after the first occurrence, to spread post-disaster mitigation, and to improve community resilience. Tables 2–4 shows the keywords, phrases, and popular hashtags that emerged during the 2018 Lombok earthquake in August 2018.

3.2. Local communication networks during and after earthquake events

Disaster management and emergency response procedures in Indonesia have shifted from government-centric decision-making in Jakarta to local and regional authorities. The first response to a disaster is expected to arrive from a government bureau or institution, and when the emergency services that have been established at the regional level respond, this leads to decentralisation. This system of decentralisation has been considered effective, as it has brought several benefits, such as more transparency, the strengthening of local government, and an improvement in the services local and regional governments can provide for their communities (Kahkonen and Lanyi 2001). It is claimed that public services related to disaster mitigation are more effective if they are applied directly at the local level or through a decentralised system. This is because the process of management, particularly regarding emergency and disaster incidents, can be handled more quickly and in proximity to the problem occurring in the local communities.

The implementation of regional autonomy regulations in Indonesia has brought about a change in disaster management and the reformation of bureaucracy at the local and regional level. Putra and Matsuyuki (2019) suggested that the reformation of disaster management at the local level by the regional government in Indonesia has brought some positive impacts; in particular, it has provided opportunities for the regional government to establish and develop its own relevant and specific systems that suit their communities in recovering from natural disasters in their local area. This system also allows local and regional governments to anticipate future natural disaster events based on the degree of physical damage caused by previous disasters. Unfortunately, the delegation of resources from the central government in Jakarta to local and regional authorities to handle and manage any disaster events has not yet followed the implementation of the regulations.

Six months after the largest earthquake in Lombok, this research interviewed local authorities, government bodies, and some of the key informants related to disaster management and mitigation. We found that there were long pathways of communication, with networks of bureaucracy that required procedures to be followed through central command for emergency responses, in which the Indonesian president was still the first point of contact (Figure 6). In such a situation, the president gives a

Table 3. Top words pairs in comment in entire graph.

[657]	di,Lombok
[360]	Allah,swt
[332]	ada,gempa
[318]	gempa,susulan
[231]	tidak,ada
[206]	yg,di
[197]	kita,semua
[184]	gempa,di
[184]	lindungan,Allah
[181]	terjadi,gempa

Table 4. Top hashtags in comment in entire graph.

[17]	#prayforlombok
[9]	#BMKG
[8]	#PrayForLombok
[5]	#Gempa
[4]	#bmkg
[4]	#ask
[4]	#Prayforlombok
[3]	#BreakingNews
[3]	#PRAYFORLOMBOK
[3]	#Pemutakhiran

command to the provincial governor, who then sends the command to the local military command. The command is then passed on to the local government board of disaster management and response. So the provincial governor and local military authority remain in charge when directing commands and they receive any reports from lower levels. This communication and command system is too slow and ineffective when looking for prompt first responders and external support during a disaster event. This centralised chain has made local villagers and disaster victims prefer to ask family members and close friends to act as first responders, and not those regional authorities, during a disaster.

Moreover, from the interviews with the affected victims in the two villages in Lombok, this research found that the communities complained and described difficulties when they requested first-aid and support during and after the disaster, particularly the villagers who lived in the hills, like Genggelang village in North Lombok. As a result of the inefficient bureaucracy command system, the villagers in Genggelang initiated self-healing and cleaned up their village following direct commands from the head of the village and their traditional cultural leaders, such as religious leaders, elders, and village activists.

Putra and Matsuyuki (2019) reported that the decentralization of disaster management in regional Indonesia formed social networks that involve elements from local authorities. They compared the patterns of social networks between actors that had been involved in disaster management before and after decentralization in regional Indonesia. Their study showed that before the decentralized regulations, disaster management in Indonesia was placed in the hands of the Ministry of Home Affairs, who became the dominant and centralized actor. The ministry administered the largest networks to organize, coordinate, and send commands to lower levels in regional areas, whereas after decentralization took place, the governing board of disaster



Figure 6. The pattern of central communication command for emergency responses in Lombok.
Source: Author.

management and the response was established in all local and regional places across the country, and the role of the Ministry of Home Affairs was replaced by the BNPB at the national, regional, and district levels. However, this does not mean that the role of the Ministry of Home Affairs disappeared, as the minister remains in control of local and regional institutions and apparatuses, including provincial governments, district authorities, city mayors, and other government bodies and institutions, such as the Board of Regional Development.

Nonetheless, the pattern of a communication network between local BPBD authorities and community institutions after disasters and mitigation processes is different compared to the centralized command pattern. During the mitigation processes, the head of the BPBD and the field coordinator become the central control and coordinators for post-disaster mitigation (Figure 7). Interestingly, in this pattern, during the mitigation processes, the BPBD in West Nusa Tenggara Province involved the association of journalists in Lombok as part of its communication network. The media

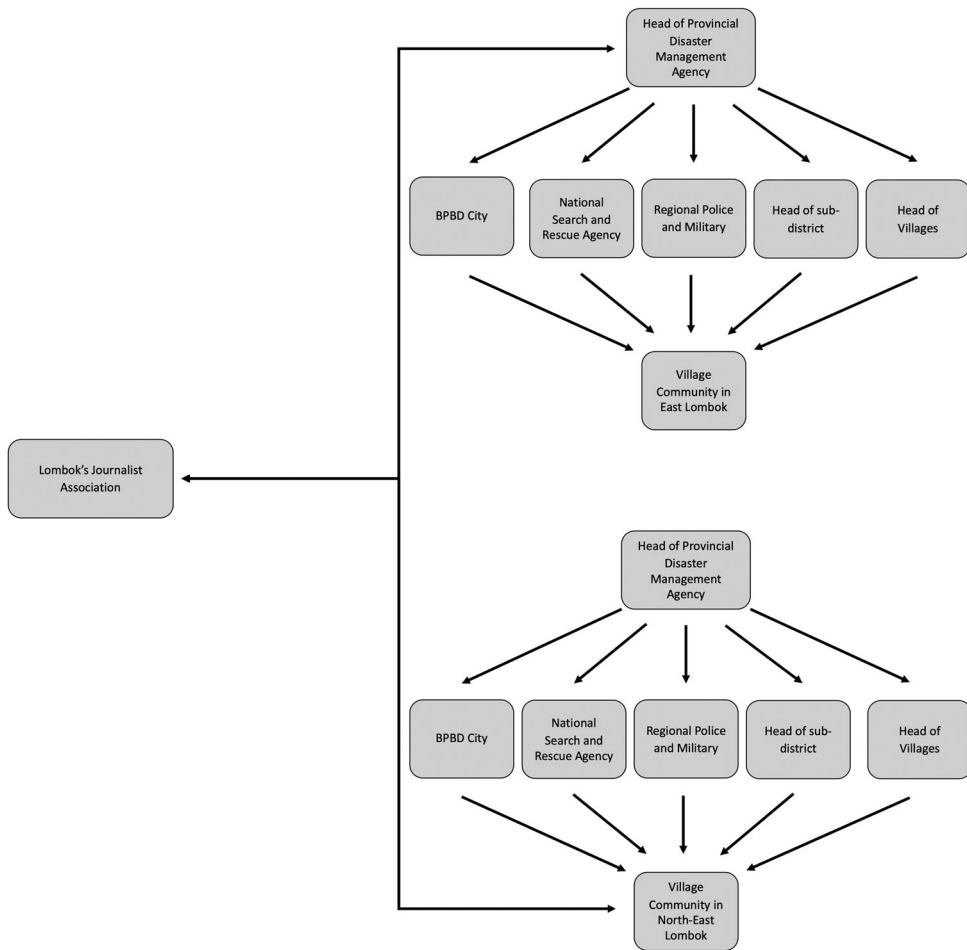


Figure 7. The pattern of communication network for emergency and post-disaster mitigation in Lombok. Source: Author.

(journalists) should be involved in emergency response and post-disaster mitigation processes as they can publish the news and control the “official” information to counter the circulation of fake news or hoaxes, which were highly prevalent during the earthquakes in Lombok. This pattern is distinct from other patterns of communication networks during disaster management in other regions.

In this study, we have attempted to outline the patterns of communication networks for disaster management, response, emergency services, and post-disaster mitigation. The aim was to understand the communication networks occurring between the government, local authorities, and the people or victims during and after the recent earthquake disasters in Lombok. The current study chose not to begin interviewing and outlining communication patterns from the upper levels of the regional government and other local and regional bodies and institutions in West Nusa Tenggara Province and districts in Lombok. Instead, it started to outline the communication patterns and response management during disasters and mitigation processes post-disaster from interviewing the lower levels: the survivors and communities that had been directly

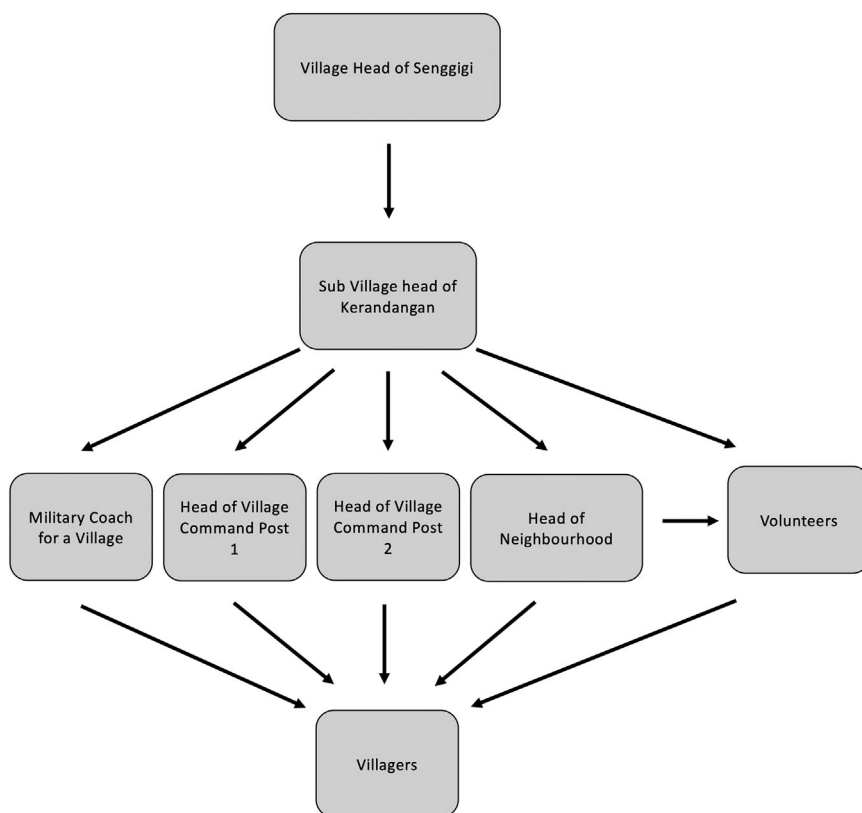


Figure 8. The pattern of the communication network for disaster response in Senggigi village, West Lombok. Source: Author.

impacted by the earthquakes in July and August 2018 and the post-disaster mitigation in May 2019. By doing this, this study has uncovered the stories and feelings of local communities regarding the issues of late responses and lack of support coming from the government during disaster events, the government's ignorance of the victims, and how they found external support by themselves and through their existing social networks, such as their families, relatives, and friends outside Lombok whom they had known before the disaster occurred. Therefore, both villages studied in this research have now established a pattern of communication networks, which can be applied in their everyday lives, in times of emergency, and future earthquake events in their community. The following graphs are the patterns of communication of the two villages, Senggigi village, West Lombok, and Genggelang village, North Lombok, which saw significant physical damage during the earthquakes in Lombok in 2018.

In the case of Senggigi village, the actors who played a major role in conveying information to the villagers and who acted as a liaison between the villagers and the authorities during the disaster response and mitigation were mainly people who were familiar to the villagers (Figure 8). The local community believed that these actors could lead and represent the villagers when dealing with the government and external support and assistance when seeking temporary shelters, food, medicines, clothes, water, and other items that they needed after the earthquakes. In Senggigi, people

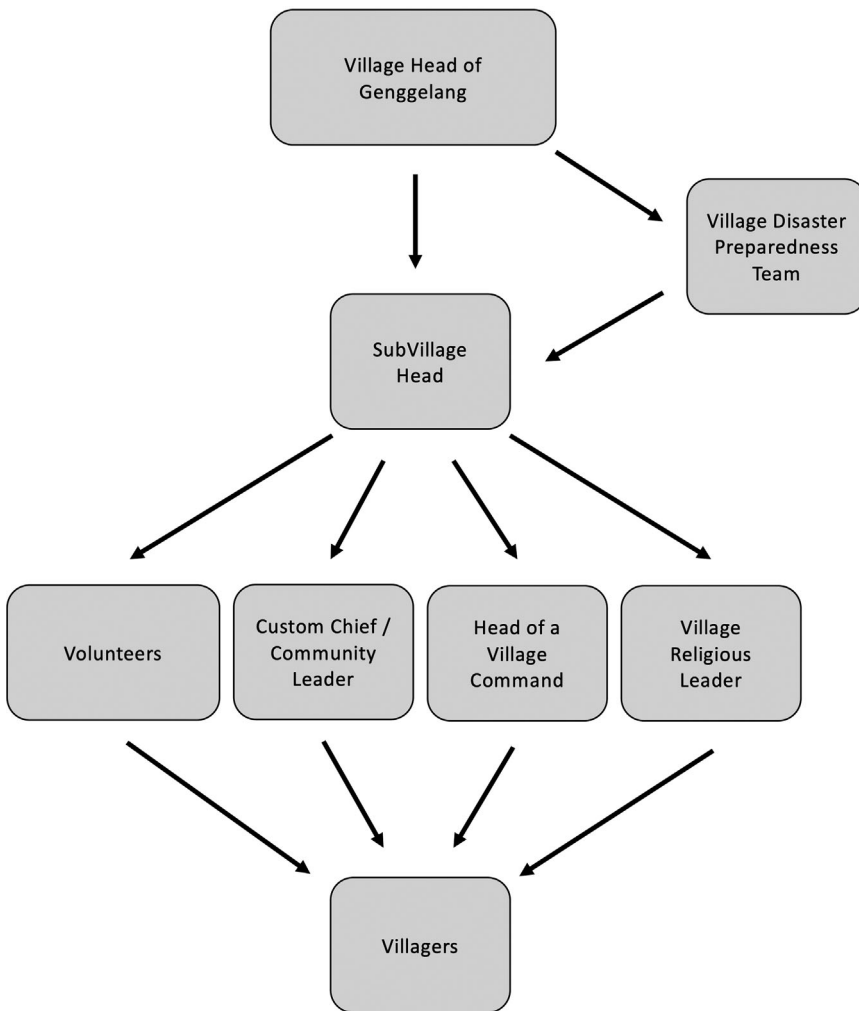


Figure 9. The pattern of communication network for disaster response in Genggelang village, North Lombok. Source: Author.

such as Mr Amin, Mr.Supaedi, and Mr Hanafi, who had become the leaders and heads of village command posts, were those chosen by the villagers interviewed in this study. The researchers interviewed 50 people in Senggigi, mainly adults and heads of families, about the first responders and whom they asked for help and assistance at the time of the disaster and the post-disaster mitigation. According to the villagers, these leaders not only provided suggestions and advice to the villagers as victims but they also liaised with volunteers and other aid institutions and NGOs that came to deliver aid and help the villagers to rebuild their houses, and who distributed goods. Mr Amin, a young adult male who had been born in the village and was the son of a former village head, was the most active leader who frequently coordinated with disaster support parties, including the volunteers who helped with post-trauma healing, especially for the children in the village. Mr Amin downloaded the official mobile application of BMKG to remain updated with current situations and received

the latest information about weather forecasts and geophysical movements following the main earthquake at that time. Any information received by him, he then forwarded it to his community members.

Meanwhile, in Genggelang, located in North Lombok, the dominant actors who played important roles to liaise between the villagers and the external responders and institutions were the head of village command posts, like Mr Sati, the most prominent figure in the community (Figure 9). Another actor who was dominant in the community network in Genggelang was Mr Amil, an Islamic religious leader who was highly respected by the villagers. Religious leaders remain influential in such traditional communities, and his suggestions and advice were important and followed by the villagers. A religious leader is always needed to guide the moral and religious life of the community. Unlike villagers in Senggigi, the villagers in Genggelang chose to gather with their family and neighbours during the disaster and in the weeks immediately following the earthquake. They built temporary shelters and tents adjacent to each other to live together. Genggelang is situated on a hill of coffee plantations and is far from the central town of Lombok. When the community did not receive any first response or aid from the local government and external parties, they built their shelters in their front and back yards, with up to 20 families living in each shelter, and they fed themselves with fruit and other edible plants available in the village to survive.

4. Conclusions

This study has found different patterns of communication network patterns. The network structure from the Facebook page of BMKG presents fewer clusters than the pattern from the BNPB's page; however, the networks formed on BMKG's page were denser, shown by the smaller number of edges of connection. This study also found that the density of the network depended on two things: the issue or topic being discussed and the popularity of the Facebook platform. The topics that received the most attention and responses from the users were about the degree of the damages caused by the earthquake and the sympathy of external users/the public to the victims who had lost their homes and belongings. However, what was missing from those issues discussed were the actual responses or activities carried out to help the victims. In other words, the posts, comments, and discussions were more discursive and not focused on "real" activities such as asking Facebook users to show their support in terms of fund-raising, social volunteering to take care of the children of the disaster victims, and so forth. Nevertheless, the formations of social networks resulting from the application of NodeXL software could have a significant purpose as a means of understanding the external support and network needed to provide aid, first responses, and public connections during the earthquake disaster and the mitigation processes.

Moreover, with the software, the different kinds of ties and actors' connections in the networks could easily and quickly be identified. In terms of actor identification, NodeXL could only identify the largest node circle, i.e., the actor with the largest number of ties and edge connections, and who fulfilled a greater role within the social network. The influence of actors was indicated by the number of responses towards the actor's posts and comments. However, the socio-demographic and

geographical backgrounds of individuals who achieved a large number of connections could not be identified. As such, the network data resulting from the software could only be processed based on the time when an issue was discussed, and not, for instance, on the users' geographical boundaries. The researchers were also unable to detect the roles played by the actor(s) in the network; they could only count the number of ties and edges of connections presented. In addition, the actors could only be identified by names; how well-liked they were within their network connections was impossible to analyse. In this study, thus, the researchers could not detect the social and cultural position of the actors within their communities.

The network structures were completely different to the results of the sociometric graphs that the researchers gained from a survey of the interpersonal communication networks of the local community in Lombok. This study found that the local people tended to trust and believe particular individuals whom they knew well and whom they respected and relied upon in their everyday village lives, such as the religious leaders and the head of the village. In such a traditional society, traditional leaders are still highly regarded and honoured by the villagers. The head of the village, religious leaders, and key opinion leaders remain culturally influential as the real actors in their social networks and it is they who can unite the people and to make decisions for the village during a disaster event and post-disaster mitigation. Their role is important not only in terms of giving instructions and protecting the villagers but also in distributing donations, assistance, and aid from the government and other parties to the community members. The Lombok community did not rely so much on the government's quick supports since the network paths of central and regional bureaucracies were slow and complicated, involving too many parties and procedures.

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Data availability statement

Data available on request from the authors

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