

## INFORMATION EXCHANGES OF SOCIAL MEDIA EVANGELISTS DURING FLOOD: A SOCIAL NETWORK ANALYSIS

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### Abstract

Information dissemination during disaster is very crucial, but inherits several complexities associated with the dynamic characteristics of the disaster. Social media evangelists (activists) play an important role in disseminating critical updates at on-site locations. However, there is limited understanding on the network structure formed and its evolution and the types of information shared. To address these questions, this study employs Social Network Analysis technique on a dataset containing 157 social media posts from an influential civilian fan page during Malaysia's flood. The finding demonstrates three different network structures emerged during the flood period. The network structure evolves depending on the current state of the flood, the amount of information available and the need of information. Through content analysis, there were seven types of information exchanges discovered. These information exchanges evolved as the scale and magnitude of flood changes. In conclusion, this study shows the emergence of different network structures, density and identification of influential information brokers among civilians that use social media during disaster. Despite the low number of influential information brokers, they successfully manage their specific cluster in conveying information about the disaster and most importantly coordinating the rescue mission.

Keywords: Disaster, social network analysis, social media, information dissemination

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## 1.0 INTRODUCTION

Disaster occurrence in recent years has been on the rise. A disaster can be explained as a natural or man-made occurrence which leads to human casualties, loss of properties and natural environment [1]. Malaysia recently, experienced its worst disaster in decades with twelve states being hit by floods. This led to a damage that is worth over \$560 million [2].

During a disaster, information dissemination is very crucial, however, it has several complexities associated with its dynamic characteristics. Information updates need to be conveyed to the target population effectively [3-4]. This makes the emergence of online activists important due to their on-site location and reputed trust gained from the citizens. Previous studies have been conducted on organizational point of view during a disaster and how

it helps during the disaster [5] but the role of ordinary civilians and their information exchanges using social media is yet to be understood. This study examines the network structure formed by these social media evangelists, how the network structure evolves during the disaster and the types of information exchanges happen in each cluster. The finding of this study can be used to devise a more systematic collaboration in terms of information sharing and rescue coordination between civilians, non-profit organizations and government in facing future disaster.

## 2.0 LITERATURE REVIEW

Information dissemination on social media has been an area of research in recent years [3,6]. Information

tracking on the social media is difficult to identify and verify [7] which can be due to the reason that they are given out under pressure and impoverished conditions, thus the information is scattered and heterogeneous [8]. Information dissemination on social media is evident during disasters. This is visible in the case of Queensland flood and UK riots [9-10], where it was used to disseminate real-time information like warnings, live updates and relief coordination.

In recent years, emergency workers are adopting social media for prompt information dissemination to reach their target audience [11]. However, they are not well informed and equipped on how to respond to disseminated information from the populace [12]. Belblidia [13], added that information dissemination using social media is a vital addition to the traditional means of exchanging information during critical times in emergency by giving an avenue for collaboration that enhances the community resilience. Social media offers a more direct channel for information dissemination to the public [10].

Gideon [14] showed how the concise and explicit detail of the Los Angeles's fire by the civilians on the social media help in quenching the fire. Hjorth & Kim [15] in a different sphere stated that social media was used as an avenue for information dissemination during the 2011 Japan tsunami because it supported different modes of communication where it enables users to have live updates and relay information. Bunce *et al.* [9] claimed that people experienced the social media in different ways, where they used it for information monitoring and collaboration activities during the phases of the 2011 Queensland floods. Yandong [16] further demonstrated how social media being used for risk reduction and for provisions of different types of supports which helped in maintaining the victim's mental health.

These studies have provided insightful findings on the utility of social media for information sharing among civilians during disaster. However, there are limited studies that uncover; 1) the types of network structure formed among the civilians 2) how these structures evolves 3) who are the information influencers and 4) types of information shared during disaster. This study attempts to address these questions using Social Network Analysis (SNA) and content analysis method.

SNA is a technique that is used for modelling communication patterns in a social network and it highlights important people in the network [17]. It studies and examines the connections that exist between actors (people, societies, communities) and other entities in a visual way [18], It identifies the influencers (information disseminators and information bridges) in the network i.e. those with the strongest influence and those who channels vital information. This enables it to show who are the most influencer, the brokers and the outliers with the subgroups or clusters that exist within the network and how the network structure changes with events and time [19].

### 3.0 METHODOLOGY

In identifying how information dissemination was done and the key influencers during the flood, it was necessary to analyze the formed network structure. In doing this, SNA technique was used. This approach was done in four stages which includes 1) data collection, 2) data pre-processing, 3) network clustering and analysis, 4) Content analysis.

In the first stage, the data were collected from an influential civilian Facebook fan page (ICFP) using NodeXL. The data was collated on a daily basis between 24th of December 2014 to 4th of January 2015. During this period, a total of 157 posts were collected. This was followed by pre-processing by filtering duplicate vertices and tweets followed by merging of repeated edges for improving the accuracy of the analysis [21]. The network clustering and analysis was done by generating a directional graph using NodeXL. The graph was further analysed using social network analysis metrics such as betweenness centrality, in-degree, out-degree and clustering co-efficient to identify important people in the network; the information disseminators, boundary spanners and outliers [19]. The clustered network based on Wakita-Tsurumi algorithm was used in identifying active posts and identify cliques within the network [22]. Content analysis was finally conducted to examine the types of information posted and shared among the civilians. The posts on the ICFP was analyzed so as to categorize the posts into themes. This was done using KH Coder [23].

### 4.0 RESULTS

In this section, the types of network structure formed among the online social activists is presented, followed by the information on the graph density and distribution of key influencers or important information brokers. Smith [24] showed that social network sites has six different types of patterns based on the way the users interacts on the social network sites They are polarized, tight crowd, brand, community, broadcast and support pattern. These patterns occurs in respect to the different types of posts and discussions that surrounds it. Moreover, each of this pattern has its distinct properties in terms of its information spreading ability and how their relationships are formed.

#### 4.1 Emergence of Different Types of Network Structures

The network structure was categorized based on the type of network pattern that was generated. This was characterized by the number of influencers, outliers and information source [24]. In the network structure, the bigger the node, the more active they are on the page with the colored nodes being much more important than the others regardless of its size. The importance of the nodes is categorized based on betweenness centrality and social tie strength. The

nodes are represented by the blue colour (as most important) to the yellow colour. The metrics used for categorizing the importance of nodes are betweenness centrality, sum degree (Summation of the In and Out degrees) and clustering co-efficient.

During the course of the flood, there were changes in the network structure of the ICFP. It was evident that there were basically three (3) types of structure which includes the tight crowd, the community cluster and the broadcast network type of social network structure. The broadcast network pattern is formed when the nodes are connected to the source of information with the news being urgent, it needs to be repeated along the line. This then creates smaller clusters that share their own views about the news or events with many outliers (Refer Figure 1). This was seen in 24th and 25th of December.

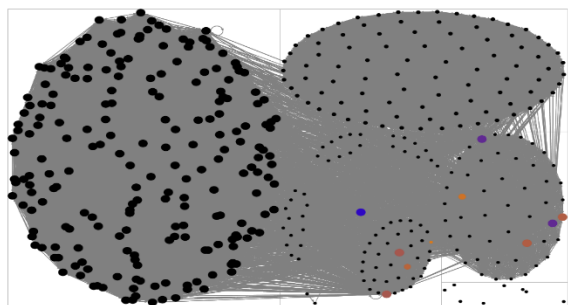


Figure 1 Broadcast network pattern of the 24th December 2014

The second network pattern that emerged among the online social activists is the tight crowd pattern. This pattern is characterized by highly interconnected nodes with very few outliers (Refer Figure 2). This was apparent on the 26th, 27th and 28th of December.

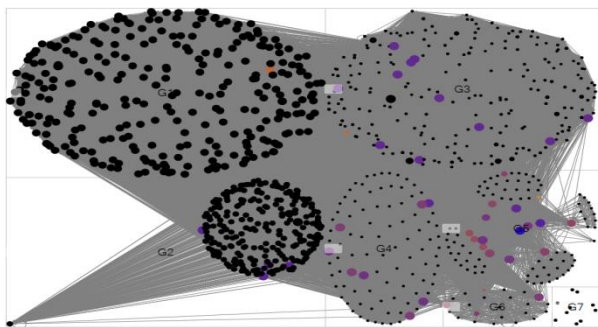


Figure 2 Tight crowd network pattern of the 27th of December 2014

Another noticeable social network structure during the flood is the community cluster pattern which is formed basically through popular discussion where several small clusters like communities comes up with each having its distinct audience and influencers with few outliers (Refer Figure 3). This was seen in 29th, 30th,

31st of December 2014 and the 1st, 2nd, 4th of January 2015.

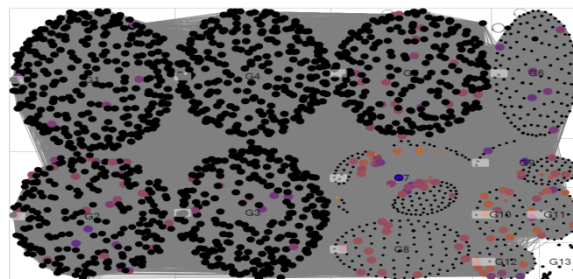


Figure 3 Community cluster network pattern of the 1st of January 2015

### 4.2 Evolution of Graph Density during Disaster

Graph density can be explained as the rate at which the vertices in the network are interconnected and it is usually between a range of 0 for sparse graphs and 1 for dense graphs [19]. It is equally a function of the number of participants. The graph density (Figure 4) was also changing dynamically depending on the state of the flood and the interactions that occurs among civilians. The densest graph was on 24th with 438 participants because of the high rate of the flood and there was a lot of interactions. The 25th was the least dense, this was due to the large number of participants (1899), which greatly affected the density because the day was loaded with a lot of posts (21) and most people just commented on a post and leave. Hence, there was little interaction among the participants. While some of the clusters generated on that day was dense with a density of 0.5 due to the severity of the flood, call for urgent help and need for donations, other posts were simply information updates with very sparse connection among the participants and thus affected the overall graph density. In subsequent days, graph density alternated between 0.2 and 0.06 with the dense period in the early part of the flood, while the less dense was in the later part of the flood. On the average, the graph density was 0.126631969 which shows that there was relative much communication on the fan page during the flood.

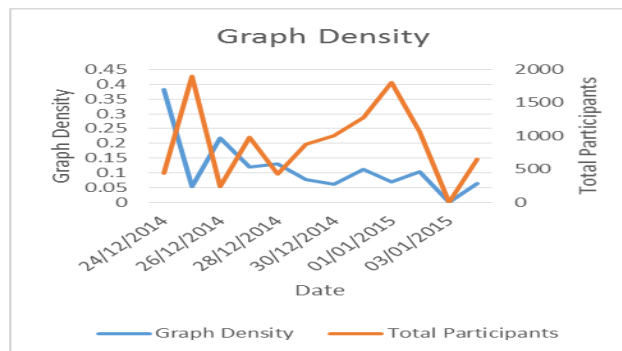


Figure 4 Graph density

### 4.3 Distribution of Influential Civilians During Disaster

As for the distribution of influential civilians, only 5% of the overall users are important and serves as an important influencers. 98.2% of the participants were active (refer to Figure 5). The key influencers were determined by their betweenness centrality while the active participants was determined by their social tie strength (sum of in and out degrees).

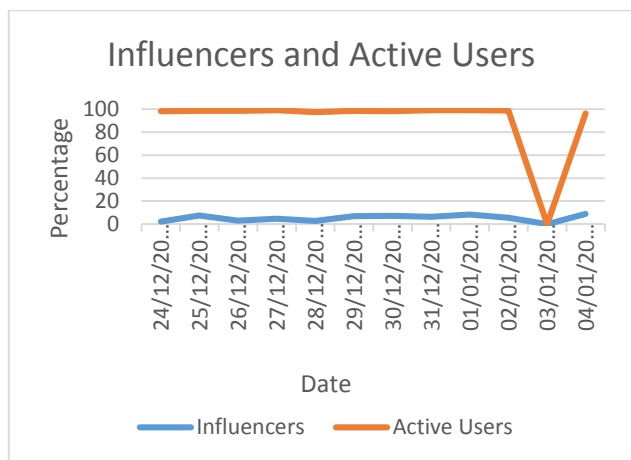


Figure 5 Influencers and active users graph

### 4.4 Gender Activity Ratio

The gender participation during the flood was unequal all through with the female much more active than male with an average of 66.6% of females to 31.4% of males (refer to Figure 6). Table 1 summarizes the ICFP network structure based on date.

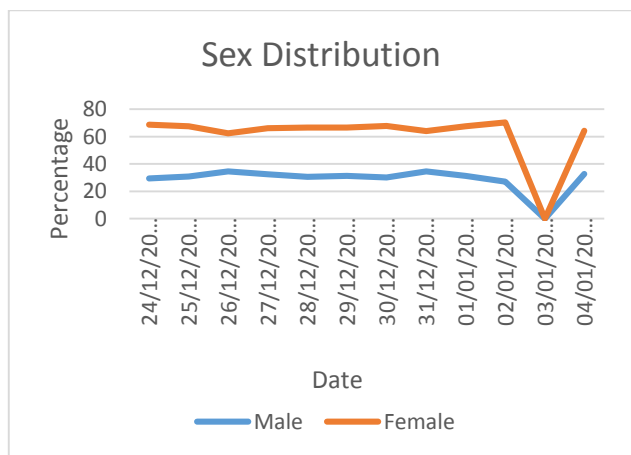


Figure 6 Distribution of participation by gender

### 4.5 Post and Cluster Analysis

With each post expected to generate its own audience, and thus have its distinct clusters, the clusters formation was not according to the post but in

respect to the interconnectivity that exist between the participants. This is visible in the case of the 25th of December where there were 21 posts with 169 clusters being formed, in the real sense there were seven clusters that much discussion was around and the remaining 162 clusters were small groups of disconnected vertices. Equally, on the 28th with a total posts of 15 had 6 clusters which showed that there was more communications and there exist a linkage between the posts that allowed inter-dialogue among the participant which forms a denser network structure. As shown in Table 1, the lower the number of clusters, the more connection exists amongst the participants and the denser the overall graph is and the lower the number of information bridges that exists in the overall network structure.

In summary, this section presents the types of network structure form and the percentage of important information disseminators that were presence on an influential civilian page during Malaysia's flood. The next section focuses on the types and evolution of information shared between them.

### 4.6 Types of Information Shared During Disaster

There were also various types of social media posts during the Malaysia's disaster. The types of post evolve as the scale and magnitude of flood changes. The categorization of the post was done using the open coding. The information exchanges were volunteering activities, donation, information updates, ask for help, consolation, victims experience and the civilian reflection. The excerpts provided in this section have been translated from the native Malay to English language to promote readability.

**Category 1:** Volunteering activities posts are the most popular type of post, surface throughout the duration covered in this study. Example includes:

*"We help based on humanity. It is very sad if the aid does not being delivered. Leave aside the political and publicity interest.... There are lives to be saved ... tomorrow we will leave after Friday prayers...volunteers needed"...*

**Category 2:** Information updates was basically used in spreading out information to the populace. The information updates may help to correct some of the misinformation spread during the flood. Example includes:

*"According to the secretary of National Security Council, Datuk Thajudeen Abdul Wahab, only a few land routes for going out from Kelantan are disconnected while the air transportation is still fully operational.... The information saying route to Kelantan is not accessible is not true"*

**Category 3:** The donation posts was basically used in raising financial and material supports for the victims. This type of information support the relief operation during the flood period.

*"Greetings... Emergency aid....We need donation of basic needs materials to be sent to Kelantan tomorrow, 25/12/2014 and we will depart tomorrow if the materials needed are sufficient"*

Table 1 Summary of ICFP Result

Day	Graph Density	Total Participants	Influencers (%)	Active Users (%)	Male (%)	Female (%)	Number of Clusters	Number of Posts
24/12/2014	0.3828	438	2.3	98.1	99.5	68.7	5	10
25/12/2014	0.0532	1899	7.5	98.3	0.8	67.5	169	21
26/12/2014	0.2191	234	3	98.3	4.6	62.4	4	4
27/12/2014	0.1201	985	4.7	98.9	2.5	66.1	7	8
28/12/2014	0.1295	423	2.84	97.4	0.5	66.7	6	15
29/12/2014	0.0765	869	6.8	98.3	1.3	66.7	9	16
30/12/2014	0.0621	1002	7.1	98.1	0.2	67.8	11	17
31/12/2014	0.1130	1269	6.5	98.9	4.6	64.1	9	12
01/01/2015	0.0688	1801	8.4	98.9	1.2	67.5	13	16
02/01/2015	0.1033	1068	5.6	98.8	27	70.4	6	14
*03/01/2015	0	0	0	0	0	0	0	0
04/01/2015	0.0645	647	8.8	96.1	2.7	64.3	12	24
Average	0.1266	966.8	5.8	98.2	1.4	66.7	22.8	14.3
Standard Deviation	0.0971	537.8	2.3	0.8	.2	2.3	48.6	5.7

\*The data for the 3<sup>rd</sup> of January could not be obtained and was not considered in the analysis, thus does not affect the overall result.

**Category 4:** In this category, request for help on stranded area during the flood was posted so as to help in rescue co-ordination and the ease of locating victims that needed the help. It appeared sparingly in the overall network structure and mostly at the beginning of the flood. Example of the post include:

*"Manek Urai School has been the flood rescue centre, but water level is rising till the top floor where all the victims are staying..."*

**Category 5:** The consolation category posts are used as a means of consoling and giving support to the affected victims. It appears very rarely with it showing 4 times in all. Example of post in this category include:

*"I plead to all of you reading this post to pray for the recovery of this flood disaster"*

**Category 6:** The reflection category which is primary personal reflection about the flood, lesson learnt and mistakes made. It is seen basically towards the end of the duration of the study.

*"This disaster has unite us physically and virtually. This disaster force us to place our focus to a central issue which is helping the flood victim"*

**Category 7:** The victim experience category is made up if posts where the victims share their ordeals during the flood period. Example of post in this category includes:

*"One doc shared her experience... She is working in hosp. Let's pray for these flood victims. If the water does not subside, maybe the patients will be evacuated using helicopter because the oxygen supplies cannot last long. The electricity in the city has been cut-off. We are using generator at the hospital which probably lasts 24-48 hours."*

Figure 7 demonstrates the distribution of the post based on their categories. Volunteering activities posts represent almost 50 percent of the total number of posts, followed by information updates, donation and other types of posts.

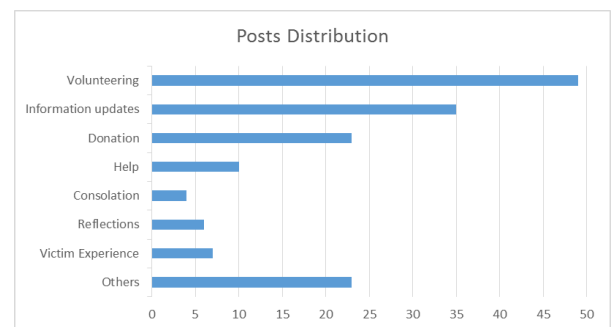


Figure 7 Posts distribution based on their categories

## 5.0 DISCUSSION

The findings demonstrate three types of network structures which changed in succession and was formed due to three reasons:

1. The current state of the flood.
2. Amount of information available.
3. Nature of the need of information.

In the earliest stage of the flood, the broadcast network pattern was formed. This is due to the

sketchy information available mostly based on words of mouth (WOM) with very limited first-hand information. Due to this reasons, there was an urgent need for information updates reflected by the broadcast pattern.

At the mid-stage of the flood, the tight crowd pattern was formed due to the signs of the flood beginning to recede. During this period, more people were getting informed about the flood and thus could deliberate and discuss effectively about the flood. The civilians also have the ability to corroborate story in the media houses with the victim's experience. At this point, the need for urgent information updates was getting relatively lower with people more concerned on the importance of helping the affected victims of the flood. Thus, there was heavy and focused deliberation about volunteering and donation. This was much apparent as most discussions were centered in this sphere and everybody was speaking in the same language and motivated by similar goals and rescue mission which made the people highly interconnected with very few outliers.

During the end of the flood period, the community cluster pattern was formed. There were much information about the flood and circumstances that surrounds the flood. This enables people of like minds to discuss in small groups with each of them having their own influencers. Additionally, the civilians have polarized themselves into smaller focused groups (clusters) specifically for organizing and co-ordination of rescue and donation activities as a supplement to the influential civilian himself. This gives room for more civic engagement while the distinct cluster influencers were still apparent in the co-ordination of their clusters.

The page had an average of 967 vertices with an average density of 0.1266 of 157 posts in 10 days. With the graph getting less dense as the flood recedes, which was a direct result of much people coming to see and read about news but not really getting involved. This was seen on the page, but still, there was much deliberation and aggregation that was done. In contrast to the volunteering and donation which gave people room to discuss. This made more people feel interconnected and want to see things through on the page. This shows the tendency and trustworthiness people tend to accord each other on social platforms. Based on the interaction, the people had a feeling of individual responsibility towards the flood victims because a civilian like them is putting effort in making life easier. This made the social platform to serve as an encouragement avenue for people to keep in touch, keep participating and follow things through.

In terms of information brokers, it could be seen that the percentage of influencers in the network structure is low. This finding is indicating the need for enhanced information dissemination process so that information disseminated can reach the target audience in the shortest possible cycle [3,6]. It could be seen that the influencers increased as days pass

by from 2.3% on the first day to a peak of 8.8% on the last day. This depicts how minute the information brokers are. The low number of information brokers initially was due to the reason that much details about the magnitude of the flood was still sketchy with most people relying on the word of mouth or news break from media houses. Only an onsite person can give real-time updates. Later, as more details about the flood surfaced, more information disseminators appeared in the network and more information bridge with very few boundary spanners.

Females were more active on the page which was equally seen in the previous study [5]. This may be attributed to the female's nature of compassion and emotional feelings towards the flood victims. It would be necessary to determine if there is more IT literacy amongst the female than the male, or the females are more used to social networks than their male counterparts that led to this wide gap in online activism.

This study shows the importance of enhancing the need of information influencers during the disaster because even at the peak of the influencers, they were less than one-tenth of the whole population. This gives high room for the possibility of misinformation to the public through an unidentified source. Equally, the need for information to be able to reach the population in the shortest possible cycle is very important to be improved so that crucial details can be gotten by the populace as soon as it is available and when needed as information validity is based on spatio-temporal context.

This study equally shows how civilians used social media for deliberation and aggregation which led to unified decisions that enabled ease of contribution to the flood victims and coordination of rescue operations. This further deepens the need for more research to be done in the area of developing real time decision support system that helps in making prompt decisions from aggregated real time social media data so as to prioritize aids and relief operations.

## 6.0 CONCLUSION

In conclusion, this study shows the emergence of different network structures, density and identification of influential information brokers among civilians that use social media during disaster. Despite the low number of influential information brokers, they successfully manage their specific cluster in conveying information about the disaster and most importantly coordinating the rescue mission and donation. This study further raise the call for more research to be done in integrating the online collaboration between civilians and other organizations for disaster rescue and recovery. This study highlights the opportunity for dynamically mining social media data for real time decision support system for rescue and disaster recovery.

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