

A 2-way geo-crowdsourcing approach in flood relief coordination and distribution

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Abstract. Over recent years, the use of Web 2.0 social platforms and geo-crowdsourcing in disaster management and emergency responses has become common. The emergence of various communication channels has led to abundance of information, but it cannot be used directly by the first responders and flood volunteers in their responses for several reasons. This paper proposes a 2-way geo-crowdsourcing framework to centralise the flood relief distribution channels using mobile geolocation technology. The framework is anticipated to be suitable for use by flood volunteers, including NGOs, private agencies and ad-hoc volunteers, to systematically distribute the relief items to the victims. The lessons learnt from the NGOs previously involved in the volunteer efforts in the 2014 Kelantan massive flood were discussed and become the basis of this framework. The framework could be applied for other studies that seek to support a 2-way communication between netizens and the authorities using a geo-crowdsourcing platform.

1. Introduction

The past 2014 massive flood disaster that hit several places in Malaysia, particularly Kelantan, was recognised as the worst flood in a decade [1]. The economic loss from this disaster was estimated at RM 2.5 billion. According to [2], there was continuous extreme rain between 17 to 24 December where the reading at ten stations shown average rainfall value of 580 to 1765 mm. This record was high as the annual rainfall of Kelantan is about 2300 mm to 2500 mm per year [3]. The water level was recorded as several meters higher compared to the worst flood that hit in 1967 [4]. The highest water level at Sg Kelantan in Kuala Krai for example were recorded at 34.17 m (normal 17 m) [5].

Notwithstanding the anticipation and preparedness by both federal and state authorities on the occurrence of seasonal monsoons every year [6], the extent and the intensity of the disaster was indeed beyond what had been expected. Several areas were deserted with power outage with more flood victims seeking for help and even the hospital under water. Despite considerable efforts by the authorities, individuals and NGOs from all over the country, many have publicly concerns about the



lack of coordination when dealing with a disaster of this magnitude [7], [8], and [9]. There were some areas that were overloaded with relief items and several victims received redundant items, whereas, in other areas, there was a lack of aid and relief supplies for several days. There were wasted resources in the relief centres, such as old clothing, as the need for these items were underutilised. The large surplus of items could be due to the needs of victims being seen differently because of culture and preferences.

The advancement of Information Communication Technology (ICT) and the proliferation of social media channels have led the authorities and netizens to share and acquire information as well as virtually work collaboratively to achieve the same ends. For example, in the Haiti earthquake in 2010 [10], the authorities and citizens worked collaboratively to generate a crisis map using an Ushahidi platform. The local data contributed by citizens were acquired by using pre and post disaster satellite images identification platform, geolocation mobile app technology or social media to supplement authoritative data for the disaster response. A similar geo-crowdsourcing approach was used during the Japan earthquake of 2011 [11] and the Nepal earthquake in 2015 [12]. Crowd sourcing platform has been also used in the recent Coronavirus outbreak. For example, MaskGoShare [13] to share locations to get free mask in Singapore and CoronaTracker [14] developed by Malaysian Data Scientist to track and map reported affected victims from news and credible sources worldwide and consolidated into one crowd source platform. Due to the importance of sharing credible crowd source data [15] and the fact that data generated from the crowd may have inconsistent quality [16], [17], the platform pools a group of regional volunteers draw from medical experts who will verify news reports and data scientist who will process and clean data before it is being posted in the website.

As has been discussed by [18], various online services have been used by the authorities to share the status of disaster and emergency responses that have been conducted. The netizens used social platforms to share information such as the blocked roads due to flood and the aid and relief requested by the flood victims. However, the lack of coordination resulting from a disintegrated and non-centralized information from these sources have led to total confusion and thus poses a hindrance towards an effective aid and relief distribution.

For example: the e-Banjir Negeri Kelantan [19] portal was used to update the status at each evacuation centre, water levels, etc.; the Public Info Banjir [20], developed by the Department of Irrigation and Drainage Malaysia; the Portal Bencana [21], developed by the National Security Council, Prime Minister's Department; and the JKR Disaster Management Centre [22], developed by the Public Work Department, were all used to share their authorised data related to the current disaster. There was a mobile application, TogetherWithU [23], that integrated several platforms related to flood recovery activities. The application integrated the eBantuan Banjir portal which supplied real time authoritative data related to the status of water levels, current evacuation statistics and weather status, with the e-sukarelawan portal and related flood crowd funding pledges in Malaysia. This mobile application was supported by several organisations, including the Ministry of Communication and Multimedia Malaysia and NGOs that were actively involved in the flood recovery processes. The authorities provided a hotline landline number for each district for the public to report regarding the search and rescue operations.

On the other hand, social media, such as Facebook and Whatsapp, were also used by the public and flood volunteers to share information during the disaster. Most of the people who were not at the affected area shared the information they acquired from their relatives or contacts that were affected or involved in response actions. There were several informal Facebook accounts managed by people to share the information of the current status of the disaster in their locations, such as 'I Love Kuala Krai', 'Info Banjir Kelantan' and 'Info Banjir Terengganu'.

Through these accounts, people shared information such as roads being blocked, locations of victims still trapped in their houses and victims that required aid supplies. Social media was also used to disseminate the locations and activities to collect relief supplies organised by NGOs, private companies and ad-hoc groups. It also was used to share the reports from the victims, particularly post-disaster for specific aid actions, such as calling for owners of four-wheel drive vehicles to transport relief items to remote areas, assistance to clean and paint affected buildings, donations for books, teaching and learning accessories, etc.

In this case, the stakeholders involved in the disaster response, including the first responders and volunteers, were provided with various online services. These services have led to the creation of island information that is not centralised and integrated in the authorities' disaster management practices. The advancement of technology and the rise of netizen participation have led to an abundance of information that could be used to supplement authoritative data. Nevertheless, as argued by [11], information overload that is not filtered according to the user tasks, unfamiliarity with the online platforms developed ad-hoc, the credibility and quality of user-generated content and the acceptance of the first responders of the use of technology to assist in their response efforts, present big challenges to integrate crowdsourcing efforts into national disaster management practices. The UN-SPIDER under the United Nation plays a major role to encourage better integration of geo-crowdsourcing in national disaster management and emergency response practices so that the collaborative efforts of the public in supplying information can be used to improve the efficiency of responses by the authorities [[19].

This paper proposes an improved and centralised 2-way communication framework, namely e-Bantuan, formerly known as Op Banjir Prihatin [10] that integrates a 2 way geo-crowdsourcing approach in the flood aid and relief distribution through mobile geolocation technology.

The framework is anticipated as suitable for use by flood volunteers, including NGOs, private agencies and ad-hoc volunteers, to systematically distribute the aid and relief items to the victims.

2. Experience learnt from flood volunteers

Several personal interviews have been conducted to understand the flood volunteers' operations during the disaster. Representatives from three NGOs, including BBNGO, PAPISMA and Persatuan Royalti, which were actively involved during the 2014 Kelantan flood, have been interviewed. BBNGO is the umbrella for several NGOs, such as IKRAM HEALTH, PAPISMA, Royalti I, iBantu, HALUAN, MERCY, PASMA, IKRAM, Dewan Perniagaan Melayu Malaysia (DPMM) Kelantan, Kelab Doktor Pakar Kelantan, Kelab Ekspedisi Kelantan and NGO 4WD (4 Wheel Drive), as well as ad-hoc volunteer teams that work collaboratively in aid and relief distribution. Several questions were asked, such as;

Q1: How did you coordinate the relief efforts among various volunteer teams?

Q2: How did you distribute the relief items?

Q3: What types of relief supplies were required during the disaster?

Q4: What is your perception of the use of social media such as Facebook in the relief efforts?

The following section summarises the findings from the personal interviews with several NGOs (BBNGO, PAPISMA, Pertubuhan Royalti) that were conducted between 15 and 18 August, 2015.

2.1. Relief coordination

The command officer for each area held a meeting every night with the volunteer teams to keep an update of the places that had not yet received relief supplies and to approximate the number of relief items to pack and the number of packs to be distributed to the flood affected areas on the following day. The frequent meetings were to eliminate redundant relief efforts by other volunteer teams. The medical teams were allocated to specific areas according to the needs. The ad-hoc volunteers arriving from various places to join in the volunteer efforts were recorded manually to ensure safety during the visits. The NGO divided each targeted location with one 4-wd vehicle that could accommodate from five to six volunteers.

2.2. Relief distribution

The relief supplies that were received by various agencies and individuals were recorded manually. The items were recorded according to the date and time of arrival, the donor contributions, the type and the sponsors. However, they did not specifically record the received donation items as their purpose was to deliver all the items to the victims.

Mobile clinics were temporarily set up to provide treatment to the victims. They used helicopters to transport victims that required intensive treatment to the hospital. The relief supplies were delivered to the flood victims by 4-wheel drive. They were distributed from house to house and tent to tent to ensure the items were delivered transparently. The NGO distributed goods based on the requests received from the victims, due to transport limitations.

2.3. The type of relief items

During disaster, the victims required basic necessities such as drinking water, dried foods, medicines, clothes, adult and child diapers, sanitary napkins, candles, flashlights, soap, toothpaste and toothbrushes, pillows, towels, Telekung, scarves, matches, tents, slippers, stoves, etc. Infant formula was not recommended during floods, because every baby has different requirements. Moreover, during the flood, the water supply was disrupted and not safe to consume and may have caused the baby to get an infection. The common medicines required during floods are cough medicine, fever relief, painkillers, paracetamol and drugs for hypertension and diabetes. Vegetables were not required during the floods, but dry food, such as instant noodles and vermicelli, was encouraged. During the post flood disaster, the temperatures at certain affected areas fell to 19 degrees Celsius; hence, the supply of mattresses and blankets was required.

2.4. The use social media in the relief efforts

The NGOs did not rely much on social networking sites because of the time constraints to extract the huge amount of information generated through the channels. From the reports retrieved from social networking sites, they would verify the accuracy of the information by contacting the volunteers' representative in the reported area before confirming the reports. The number of victims for specific areas was updated by the field volunteers to the relief centre using phone calls. There was a specific group network using Whatsapp mobile app to update the information. They will verify the correctness of information acquired by contacting the volunteers' representative in the reported area to confirm the reports.

3. System workflow and implementation

The Figure 1 depicts the proposed of 2-way geo-crowdsourcing architecture of e-Bantuan system. The framework consists of mobile and web components. The mobile component is designed to use by the flood field volunteers to report and update to the system of the volunteer efforts that have been conducted using geolocation technology. The built-in GPS that is commonly integrated in a smartphone will be used to position volunteers automatically without a need to key-in the current address.

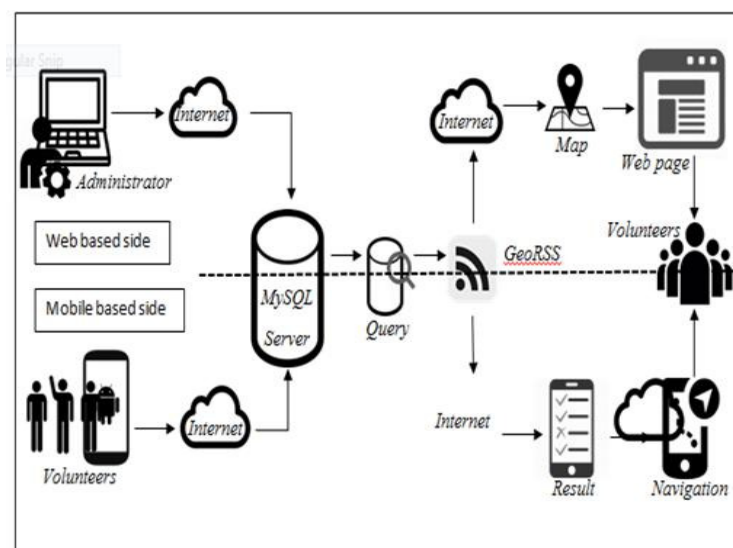


Figure 1. The architecture used in the e-Bantuan system.

The reports can be submitted to the system via both online or offline synchronization mode, especially when there is a lack of internet access. The e-Bantuan framework allows mobile users to retrieve information from the server that administered by authorities. They can receive updated information from the server, particularly the supplies that still required for specific location. This module is designed to tackle the issue of overloaded and lack of supplies in certain area.

Figure 2 presents the mobile components provided in the system for users (i.e. volunteers). Volunteers can perform several tasks through this user interface including:

- Recording the locations and details of relief efforts either have been or need to be distributed.
- Recording the location that act as temporary relief collection centre.
- Connect with online map navigation application to show the route to the reported location in the system
- View reports from other volunteers related to relief distribution that managed by system administrator
- Synchronisation of the reports stored in the mobile database with the database in the server

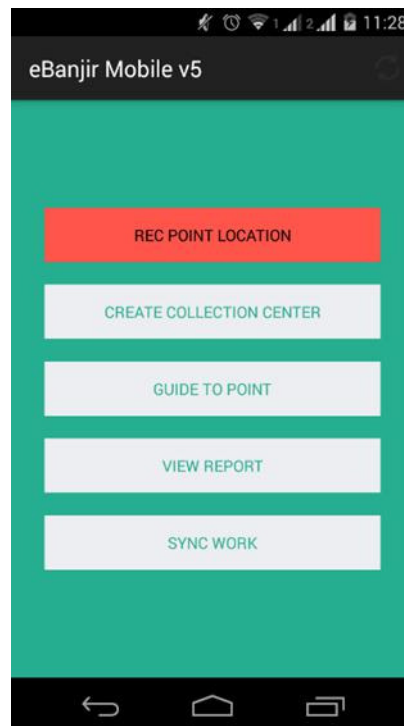


Figure 2. The main mobile user interface in e-Bantuan

The mobile component allows volunteers to navigate to the reported locations that require relief efforts using the Google Map Navigator. The intelligent module in mobile component allows volunteers to make task based queries based on their current positions; the module will search the relevant information that fit with their tasks, such as the relief items that have been distributed and vice versa within certain radius. They can search the number of victims that request for the relief efforts, and then navigate to the location.

According to the personal interviews that have been conducted, the respondents mentioned there were different requirement of supplies either during or post disaster. Therefore, the user interfaces to record the relief distribution are designed according to these two conditions. Moreover, the respondents highlighted on different household might require different supplies. Therefore, the system provides a series of supplies checklists to record the supplies that have been distributed or still required by the victims.

Figure 3 presents the mobile interface for volunteers to report their surveys of flood victims and their relief distribution efforts. Figure 4 presents the mobile interface for reporting relief distribution during post disaster.

Track And Trace
Latitude : 1.56187107
Longitude : 103.6559679

SEMASA BANJIR | LAIN-LAIN | PASCABANJIR

Keperluan Bekalan

Family Pack :

Medic :

Isi Rumah

Lelaki :

Perempuan :

Kanak-Kanak :

Catatan

Bantuan diperlukan segera

Adakah Bantuan Sudah Disalurkan? :

SIMPAN

Figure 3. The mobile interface for volunteers to report the location and details of flood victims during disaster.

Track And Trace
Latitude : 1.56187107
Longitude : 103.6559679

SEMASA BANJIR | LAIN-LAIN | PASCABANJIR

Keperluan

Bekalan Air Bersih :

Peralatan Membersih :

Toto :

Selimut :

Family Pack :

Gas Memasak :

Dapur :

SIMPAN

Figure 4. The mobile interface for volunteers to report their relief distribution during post disaster operation.

In the web component, the system is designed to record the data submitted by the flood volunteers via mobile component and integrate with disaster response data from the authority. Figure 5 present the main web user interface for the authorities to view the submitted reports by volunteers. The map showing the locations of victims that requires relief supplies as reported by volunteers. The data recorded in the system can be shared to the mobile volunteers via GeoRSS feeds. The data is filtered based on the user task via dynamic query functions.

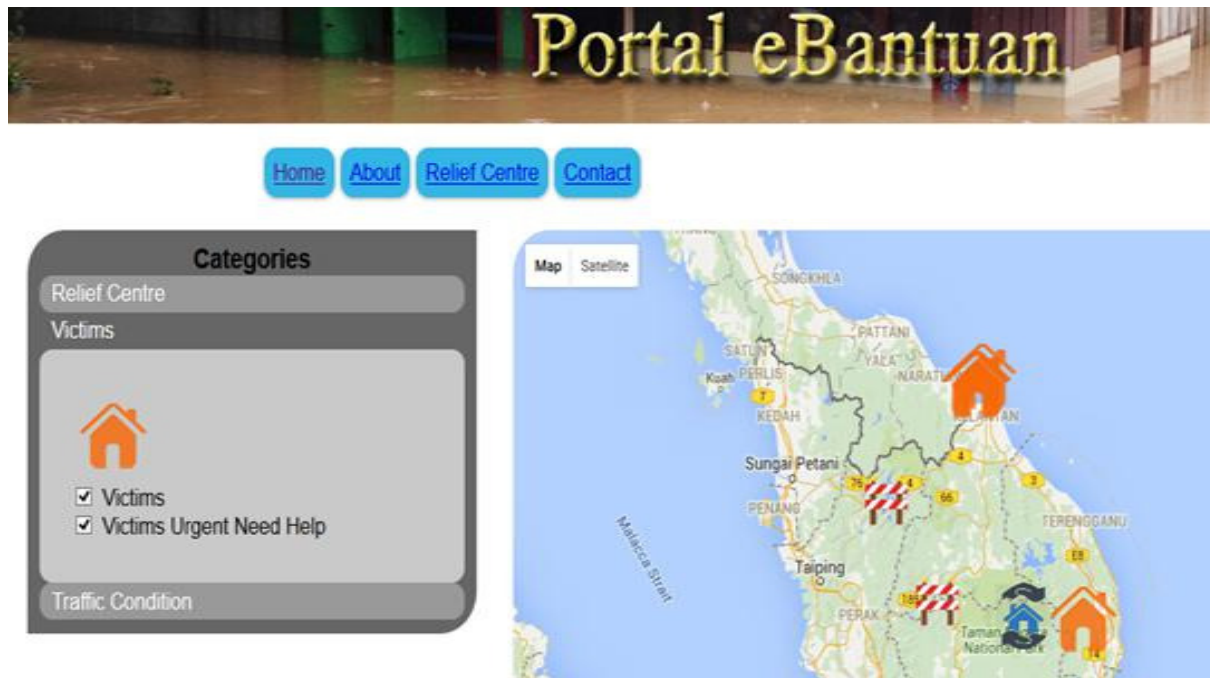


Figure 5. The online map to view the reports submitted by the volunteers to the system.

In this 2-way geo-crowdsourcing framework, the end users such as the first responder and flood volunteers can report the aid and relief efforts that have been conducted to the centralised system; the flood victims can report their requests for flood relief via mobile component. The centralised system will dynamically accumulate the reports submitted to the system and integrate with statistic reports supplied by authoritative sources. Figure 6 presents a sample of results that showing the available supplies for specific relief centre. This module able to dynamically generate either the available supplies for each area or the quantity of supplies that still required by using algorithm (1) as below:

$$B = \sum_1^{n_1} R_n - \sum_1^{n_2} Q_n \quad (1)$$

Where B = current supplies available at specific area;

R = total supplies received at the centre;

Q = total supplies required by flood victims;

n_1 = number of supplies recorded in the system

n_2 = number of reports that requested for supplies

The system could be administered by the authority and continuously update the status of supplies for each affected location to the mobile flood volunteers via intelligent location and task based queries. The system provides the information in Geo-RSS format to enable end users to subscribe and get timely updates of the reported locations that requesting for relief supplies from the system. A module in mobile version is designed to retrieve the Geo-RSS data according to specific location. Figure 6 and 7 presents a sample of Geo-RSS data that provide a list of reports requesting for relief supplies that were submitted to the system.

Bil	2
Reported By	chew2
Phone No.	012254649
Helping of	bantuan kekurangan makanan
Date	2015-07-29 00:00:17
Purpose	Disaster Relief/Disaster Relief Donation Balance
Food(ton)	1231 2313 1082
Mineral Water(liters)	2 132 130
Cleaning Equipment	232 213 -19
Baby Milk(tin)	232 32 -200
Baby Needs	Yes Yes
Daily Supplies	Yes Need
Cooking Needs	Yes Yes
GAS	Yes Need
Medication	No
Helicopter	Yes Yes
Bot	Yes Need
Four Wheel Drive	Yes Yes
Lori	Yes Yes

Bil	1
Reported By	chew1
Phone No.	102061651
Helping of	bantuan kekurangan air

Figure 6. A sample of results that showing the available supplies according to specific relief centre.

Portal eBantuan

Home About Relief Centre GeoRSS Contact

kuala krai

Bil	Food(ton)	Mineral Water(liters)	Cleaning Equipment	Baby Milk(tin)	Baby Needs	Daily Supplies	Cooking Needs	GAS	Medication	Helicopter	Bot	Four Wheel Drive	Lori
1	4543	542	277	525	0	0	0	1	1	1	1	1	1

Posted on 31 July 2015 | 12:00 am

gua musang

Bil	Family Pack	Medical	Bil Male	Bil Female	Bil Children	Additional Note
1	Ya	Tidak	1	1	1	test
2	Ya	Tidak	1	1	0	test2
3	Tidak	Tidak	0	0	0	
4	Tidak	Tidak	0	0	0	

Figure 7. A sample of data that showing the timely updates of the coming reports that links to the locations of flood victims that require relief supplies.

4. Conclusion

This paper addresses the challenges faced by the authorities to efficiently coordinate flood aid and relief distribution among flood volunteers during a flood disaster and emergency response. The proposed framework offers 2-way communication between the flood volunteers and the authorities by integrating a geo-crowdsourcing approach using mobile geolocation technology. Several limitations that might occur in the implementation of this framework have been identified. For example, the issue of no electricity or Internet access during the disaster and in remote areas, the cost and speed of data bandwidth to submit and access the reports, and the acceptance of technology among flood volunteers and victims, particularly for senior citizens, to use the proposed mobile application. The issues of data accuracy due to the use of GPS built-in enabled smartphone as has been highlighted by other scholar [25] must be carefully considered, hence demand further research. Nevertheless, the proposed crowd sourcing platform is anticipated as suitable for use by flood volunteers, including NGOs, private agencies and ad-hoc volunteers, to coordinate and systematically distribute the aid and relief supplies to the victims.

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References

[1] Azhar S, 2014 *Kelantan worst flood in the decade, say authorities*. The Star, 20 Dec 2014. Available at <http://www.thestar.com.my/News/Nation/2014/12/20/Kelantan-floods-worst-in-a-decade/> [Accessed 6 Sept 2015].

[2] Komoo I , Abdul Razak Y , Yusof Z, Pereira, J.J, Jusoh A, Ibrahim K and Rak A W 2015 *Laporan Bencana Banjir 2014: Respons, Dasar dan Penyelidikan*. Dialog Bencana Banjir, 28 Mei 2015, PWTC Kuala Lumpur.

[3] Benjamin N 2015 *Kelantan needs at least two dams to prevent flooding, says expert* The Stay, 2 Feb 2015. Available at <http://www.thestar.com.my/Metro/Community/2015/02/02/Old-measures-need-to-be-changed/> [Accessed 6 Sept 2015].

- [4] Azlee A 2015 *Worst floods in Kelantan, say NSC*. The Malay Mail Online, 5 Jan 2015. Available at <http://www.themalaymailonline.com/malaysia/article/worst-floods-in-kelantan-confirms-nsc> [Accessed 6 Sept 2015].
- [5] Idris N H, Yahya M H, Tarmidi M Z, Din A H M, Abdul-Khanan M F, Idris N H and Mat-Noor N A 2015 Kombinasi Tiga Faktor, Punca Utama Banjir Besar: Kajian Saintifik, Buletin Geospatial Sektor Awam, edisi **1**, pp 1–6.
- [6] Resdi R 2014 JPBM bersedia hadapi banjir. Utusan Online, 30 Oct 2014. Available at <http://www.utusan.com.my/berita/wilayah/kelantan/jbpm-kelantan-bersedia-hadapi-banjir-1.18360> [Accessed 6 Sept 2015].
- [7] Berita RTM 2014 TPM Saran Orang Ramai Dapatkan Maklumat Sebelum Salur Bantuan Banjir, 28 Dec 2014. [Online]. Available at <http://berita.rtm.gov.my/index.php/nasional-2/11996-tpm-saran-orang-ramai-dapatkan-maklumat-sebelum-salur-bantuan-banjir>. [Accessed 6 Sept 2015]
- [8] Astro Awani 2015 Banjir: Jangan politikkan cadangan kerajaan campur – Hissamuddin, 2 Jan 2015. [Online]. Available at <http://www.astroawani.com/berita-banjir/banjir-jangan-politikkan-cadangan-kerajaan-campur-hussamuddin-51415>. [Accessed 6 Sept 2015].
- [9] Nazaraly M Z 2014 *Banjir: Mengapa bekalan tidak sampai ?*, Sinar Harian, 29 Dec 2015. Available at <http://www.sinarharian.com.my/mobile/semasa/banjir-mengapa-bekalan-tak-sampai-1.345627>. [Accessed 6 Sept 2015].
- [10] Zook, M, Graham, M, Shelton, T, and Gorman, S 2010 *World Medical and Health Policy*. Vol.2 (2), pp.7-33.
- [11] Hong, M N 2014 *Utilization of crowdsourced maps in catastrophic disaster* Master Thesis. San Jose State University. Available at http://scholarworks.sjsu.edu/etd_theses/4418/
- [12] Leidig, M and Teeuw, R 2015 Free Software: A Review in the Context of Disaster Management. *Int. J. of Applied Earth Observation and Geoinformation* Vol.**42**, pp.49-56.
- [13] GovInsider 2020 Hackers, officials launch coronavirus crowdsourcing tools Available at <https://govinsider.asia/digital-gov/new-hackers-officials-launch-coronavirus-crowdsourcing-tools/> [Accessed 17 Februari 2020]
- [14] Business Insider Malaysia 2020 A Malaysian data scientist made a crowdsourced site to track the Wuhan coronavirus, and now people worldwide are chipping in to make it an app. Available at <https://www.businessinsider.my/a-malaysian-data-scientist-made-a-crowdsourced-site-to-track-the-wuhan-coronavirus-and-now-people-worldwide-are-chipping-in-to-make-it-an-app/> [Accessed 17 Februari 2020]
- [15] Idris, N H, Jackson, M J, Ishak, M H I 2014 A conceptual model of the automated credibility assessment of the volunteered geographic information. *IOP Conference Series: Earth and Environmental Science* **18**(1),012070
- [16] Husen, S N R M, Idris, N H, Ishak, M H I 2018 The quality of OpenStreetMap in Malaysia: A preliminary assessment. *Int. Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives* **42**(4/W9), pp. 291-298
- [17] Fauzi, M F, Idris, N H, Din, A H M, Osman, M J, Idris, N H, Ishak, M H I 2016 Indigenous community tree inventory: Assessment of data quality. *Int. Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives* **42**(4W1), pp. 307-314
- [18] Idris, N H, Fauzi, M F, Osman, M J and Ishak, M H I 2015 Engaging Flood Volunteers Through Mobile and Web based Neogeography Platform for Efficient Aid and Relief Coordination. In the Proceeding of 1st IICRIL International-Conference on Innovation in Science and Technology. 20 April 2015. Kuala Lumpur. pp. 548-552
- [19] eBanjir Negeri Kelantan [Online]. Available at <http://ebanjir.kelantan.gov.my>. [Accessed 1 Feb 2015].
- [20] Jabatan Pengairan dan Saliran Malaysia. Available at: <http://publicinfobanjir.water.gov.my>. [Accessed 1 Feb 2015].
- [21] Majlis Keselamatan Negara Available at: <http://portalbencana.mkn.gov.my/Portal/>. [Accessed 1 Feb 2015].

- [22] Jabatan Kerja Raya Malaysia Available at: <http://bencanaalam.jkr.gov.my/v2/>. [Accessed 1 Feb 2015].
- [23] Multimedia Development Corporation Available at: <http://togetherwithu.my>. [Accessed 1 Feb 2015].
- [24] Stevens, D 2008 Increasing the Use of Geospatial Technologies for Emergency Response and Disaster Rehabilitation in Developing Countries eds S Nayak and S Zlatanova *Remote Sensing and GIS Technologies for Monitoring and Prediction of Disasters*. (Berlin: Springer) pp.57-7
- [25] Fauzi, M F, Idris, N H, Yahya, M H, Din, A H M, Idris, N H, Lau, A M S., Ishak, M H I 2016 Tropical forest tree positioning accuracy: A comparison of low cost GNSS-enabled devices. *Int. J. of Geoinformatics* **12**(2), pp. 59-66