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MOBILE FLOOD ASSISTANT (MO-FA): ASSISTING FLOOD VICTIMS WITH MOBILE TECHNOLOGY

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ABSTRACT. This paper presents the features and architecture of a mobile-based application that is developed to assist flood victims and rescue teams in search and rescue operations. Mobile Flood Assistant (Mo-FA) is an integrated Android-based mobile application to assist Malaysian citizens who live in flood prone areas with an early warning alert and to facilitate the current practice in search and rescue operation. Mo-FA consists of 2 main modules namely Flood Information and Notification Module, and e-SOS Module. The Flood Information and Notification Module aims to provide early warning to the public on possible flood occurrence. It is also able to provide flood-related information such as the amount of rain and river water level using the data obtained from Department of Irrigation and Drainage (DID). Relevant information such as the nearest evacuation centers and routes will be displayed on a map to facilitate affected victims to move to a safe area. The second module aims to facilitate the rescue teams to locate the victims' whereabouts upon receiving SOS message sent by the victims. Considering the fact that mobile phone is a device which we keep close to us at almost all the time, Mo-FA could become a perfect tool to provide various flood related information and to provide a method for quick information distribution to the public and rescue teams.

Keywords: Flood Relief, Flood Management, Disaster Management, Mobile Application Development, Mobile-based System

INTRODUCTION

In Malaysia, flood is the most significant natural hazard in terms of the number of population affected, frequency, area extent, duration and social economic damage. Floods in Malaysia occur due to either monsoon floods or flash floods. Flood is a common hydrological phenomena in Malaysia, on average affecting an area of 29,000 km², more than 4.82 million people that was 22% of the population and inflicting annual damage of RM 915 million (ADRC, 2005). Balek (1983) in his study stated that flooding was a natural disaster caused by climate factors such as rainfall, temperature, evaporation, wind and movement of natural conditions on earth. Malaysia, which is geographically situated on the equator, receives an abundant amount of rain every year. The average annual rainfall is varies from 2000mm to 2500mm (6.5 to 8.2 feet) for Peninsular Malaysia, 3800 mm for Sarawak and 2600 mm for Sabah (Husaini, 2007). In fact, the December 2014 flood, which is the worst ever in the country's history, occurred due to "abnormally" heavy rainfall. The flood had caused losses amounting to billions of Malaysia Ringgit, with more than 200,000 people evacuated and 21 people killed (Malaysiakini, Dec2014). The flood that affected the east coast of peninsular

Malaysia especially Kelantan was very unusual; the water level in the rivers affected rose very quickly, thus destroying properties and government premises such as schools and hospitals.

Various efforts were taken by the government to address flood situation. In 1972, the Malaysia Government has established the Natural Disaster Relief Committee (NDRC) with the task of coordinating flood relief operations at national, state and district levels with the aim to prevent loss of human lives and to reduce flood damage (MKN 2011, Roosli 2010). This committee is headed by the Deputy Prime Minister and assisted by the committee members who come from various cabinet ministers, senior government officials and related government departments or agencies such as Department of Irrigation and Drainage (DID), Malaysian Meteorological Department (MetMalaysia), Malaysian Remote Sensing Agency (MRSA), Social Welfare Department, Police Department and Fire and Rescue Department.

In 1997, the National Security Council (NSC) Directive No. 20 was developed which contains the Policy and Mechanism of the National Disaster Management and Relief (Flood and Drought Management in Malaysia, 2007) and later being revised in 2012 to conform with the current changes, as well as the complexity of disasters (Shafiai, S., Khalid, M. S. 2016, MKN 2012). With this directive, disaster management in Malaysia has been placed under the Disaster Management and Relief Committee and the NSC is the lead agency for disaster management in the country. The NSC is responsible for coordinating, establishing and ensuring that the policies and the disaster management mechanisms are observed and implemented at all levels as per outlined in the Directive No.20.

The rest of the paper is organized as follows. The next section briefly discusses the disaster management mechanisms in Malaysia. Following this, the author introduced the proposed Mobile Flood Assistant (Mo-FA) with detailed explanation on the architecture, the modules and features of the application. The last section summarizes and concludes this paper.

DISASTER MANAGEMENT MECHANISMS IN MALAYSIA

Disaster management in Malaysia is not focused on a specific type of disaster. *Disaster* is defined by the NSC in the Directive No. 20 as an incident which occur in a sudden manner and complex in its nature and that causes losses of lives, damages to property or natural environment and bring a deep effect to local activities. Every policy issued is applicable to all types of disasters, including floods (Shafiai, S., Khalid, M. S. 2016).

Disaster management that is specific for flood management in Malaysia is based on Directive No.20 and Operation Procedure No.29 published by the NSC. Directive No. 20 outlined three (3) levels of disaster management where each committee in every level has its own tasks and responsibilities (MKN, 2011). Level I disaster is a local incident, which is controllable and has no potential to spread. This level is under the District Disaster Management and Relief Committee (DDMRC). The District committee ensures coordinated actions, including provision of available assets and human resources. This committee should be mobilized to ensure all activities of search and rescue operation, taking over and preparation of facilities and machinery and other emergency aid, i.e. food and treatment could be executed and managed in good order and is fully coordinated. Level II disaster is a more serious incident covering a wider area (two districts) with the potential of spreading out. The State level is under the responsibility of State Disaster Management and Relief Committee (SDMRC) that should be mobilized to ascertain that all disaster management run smoothly and is coordinated, and to provide assistance to the District such as financial aid, additional assets and human resources as needed. The Federal Disaster Management and Relief Commit-

tee (FDMRC) is responsible in management of Level III Disaster. They are also responsible for formulating a policy and framing a strategy towards the management of national disaster. They need to ensure that policy, rules and directive are fully respected at all levels and states. FDMRC is also responsible to introduce an education programme for the public on the prevention and preparation against a disaster. Besides that, they are also responsible to make sure that the relevant agencies are exposed to every aspect of development of training and management in handling the disaster.

Table 1 below shows the summary of these levels, its corresponding committee and their responsibilities.

Table 1. Levels of Disaster Management in Malaysia

Disaster Level	Corresponding Committee	Tasks and Responsibilities
Level I Disaster: District Level	District Disaster Management and Relief Committee (DDMRC)	Ensures coordinated actions, with sufficient asset and human resources, in relation to the media.
Level II Disaster: State Level	State Disaster Management and Relief Committee (SDMRC)	Provide to the District assistance such as financial aid, assets and human resources.
Level III Disaster: Central/Federal Level	Federal Disaster Management and Relief Committee (FDMRC)	Determine the national disaster management policy, finance, assets and human resources.

The structure and membership of the Disaster Management in Malaysia (MKN, 2011) can be referred to in Figure 1 below.

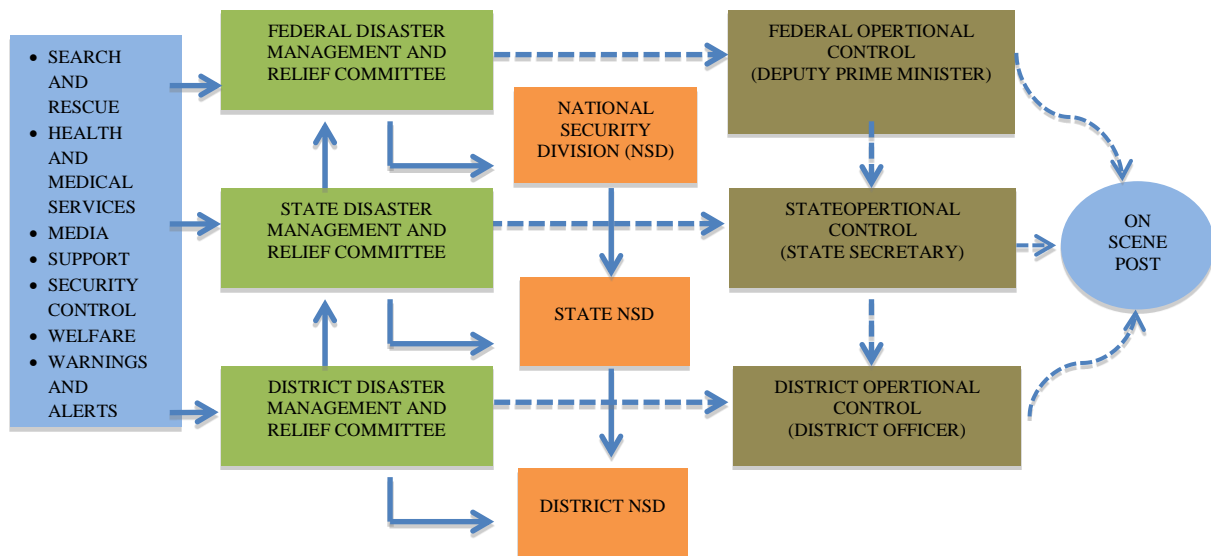


Figure 1. Structure and membership of the Disaster Management in Malaysia

In accordance to the Operating Procedure under flood relief mechanism, DID has published the Circular No. 2/2003 entitled “Guidelines for Management of Flood Disasters during the Monsoon Season and Flash Floods” which is to coordinate the preparation of flood operations at district, state and federal levels (Husaini 2007, JPS 2013). The DID categorizes the river level into three (3) levels which are Alert Level, Warning Level and Danger Level.

When the river level of any flood warning station reaches the Alert Level, DID will begin to monitor closely the flood situation. When it reaches the Warning Level, DID will inform the relevant flood control centers so that flood relief mechanisms can be activated. At Danger Level, considerable areas are flooded and will warrant evacuation of flood victims.

In addition to this, the respective state DID office also carries out flood forecast operation using real-time telemetric data (rainfall and river water level) and river forecasting computer models during the flood season to provide flood forecasting and warning services to the public. This is known as flood warning system based on river levels. Three (3) critical flood levels are designated, namely Alert, Warning and Danger. When the river water level at any forecasting point exceeds the critical level, the forecasts shall be transmitted to the Flood Operation Centers and other relevant agencies such as the National Security Division (NSD) of the Prime Minister's Department and the National and State (Police) Control Centre for flood relief/operation. To date, the real-time information of rainfall and river water level can be viewed and accessible online at *infobanjir* and *publicinfobanjir* official websites.

Infobanjir was developed as a centralized database system for the telemetry stations that receives real time rainfall and water level data. The website addresses real time flooded area and roads inundated with flood. It also displays flood forecast and landslide information for selected locations. Several on-line web cameras were also installed at several locations to facilitate visual remote monitoring. As for *Publicinfobanjir*, it is a website that developed as an extension to *Infobanjir* website. The *publicinfobanjir* website focuses on flood warning dissemination to the public, which is simple and easy to understand. It also performs flood warning dissemination via social media sites such as Facebook, Twitter and Rich Site Summary (publicinforbanjir, 2011). Short messages system (SMS) is also provided to give an alert to relevant officers in-charge of government agencies such as police, army, MetMalaysia, Malaysia Civil Defence Force (APM), DID and NSD at Prime Minister Department (Infobanjir, 2006). All government departments and agencies located outside the flooded areas received flood information either via social medias or SMS, will act accordingly following the procedures set in the NSC directive no. 20.

Other than these two official websites initiated by DID and utilized by MetMalaysia, one official portal for Kelantan State was initiated to be utilized by the relevant government departments and agencies for reporting flood related information in Kelantan (ebanjir, 2009). The Flood Control Operation Center (PKOB) uses this *ebanjir* system to bring together all departments and agencies involved to ensure no data duplication is provided to the system and to ensure all forms of operations can be arranged to flood location immediately. This system allows for comprehensive reporting through fast and accurate dissemination of information by the relevant departments and agencies. The public is able to access the system via the URL <http://ebanjir.kelantan.gov.my> (PKOB, 2015).

All of the above mentioned mechanisms were designed to be utilized and optimized by the authorities. There is no specific system or application that is designed to benefit the flood victims. One of the most significant and frequent problems faced during the flood relief effort is the late alert given to the flood victims. Flood Disaster Management in Malaysia provide SMS alert to the police, army, MetMalaysia, and the NSD, but people or victims are not being notified in the early stage.

Since flood phenomenon has become a common phenomenon for most of the population in the east coast of peninsular Malaysia, the flood victims will only wait for rescuers to come for the rescue operation and bring them to a temporary shelter or registered evacuation centers. When the worst series of floods occurred in 2014, the situation deteriorated when it rained continuously for several days and the river water level rises too fast causing an

uncontrollable situation. Most of the routes were cut off. Search and rescue operations faced difficulty due to the extent of the flood areas were wider which hard for them to get information of the exact locations of the victims. Cellular telecommunication and electricity supply were also disrupted during these bad days.

A number of interviews were conducted with the locals of commonly flooded areas in the state of Terengganu and Kelantan. Based on the interviews, it can be concluded that most of the search and rescue operations were based on the information shared by the public through WhatsApp messenger and social media sites such as Facebook, Instagram and Twitter. The transparency and accuracy of information were based on geo-tag done by the public via these social media sites.

Based on the above problems and situations, the authors believe it would be much easier if there is a system or application that can benefit by both flood victims and rescue teams for flood disaster contingency. Flood victims can query flood related information and get early warning of floods and be ready with all the important documents during the rescue operation. On the other hand, the rescue teams would be ready with all sorts of requirements and equipment for flood relief mission. Mobile Flood Assistant (Mo-FA) was designed to meet this purpose. The following section describes in detail on the development of Mo-FA. It is well-known that mobile technology is currently emerging so fast as the extensive form of the electronic communication in Information and Communication Technology (ICT). Information sharing, task distributing, alert disseminating, location tagging and photo tagging are among the norms nowadays which lead to the Information Society. Mo-FA is one of the tools contributing to the Information Society.

MOBILE FLOOD ASSISTANT (MO-FA)

Mobile Flood Assistant (Mo-FA) is an integrated mobile application to assist Malaysian citizens particularly for those who live in flood risk areas with an early warning alert and to help ease the current practice of search and rescue operation. Mo-FA is equipped with two modules namely Flood Information and Notification Module, and eSOS Module.

The Flood Information and Notification module aims to provide early warning to the public on possible flood occurrence. It is also able to provide flood-related information such as the amount of rain and river water level using the data obtained from DID. Relevant information such as the nearest evacuation centers and routes will be displayed on a map to facilitate affected victims to move to safe area.

The second module aims to facilitate the rescue teams to locate the victims' whereabouts upon receiving eSOS message sent by the victims. eSOS message can be sent through SMS or broadcasted using a wireless technology such as Wi-Fi or Bluetooth in the case of no cellular communication. Considering the fact that mobile phone is a device which we keep close to us at almost all the time, Mo-FA could become a perfect tool to provide various flood related information and to provide a method for quick information distribution to the public and rescue teams. The modules and sub-modules of Mo-FA are outlined in the next section of this paper.

Mo-FA Modules

Mo-FA was developed to have the following two (2) modules and sub-modules:

1. Flood Information and Notification Module
 - a. Flood information
 - i. Provide flood-related information from relevant authorities such as the DID and MetMalaysia.
 - ii. Provide instruction and advice to flood victims.

- b. Early warning
 - i. Send a warning message as early warning to the public on possible flood occurrence via SMS notification.
 - c. Evacuation center
 - i. Display evacuation centers within the vicinity.
 - ii. Show route to the nearest evacuation center.
2. eSOS Module
- a. Enable flood victims to send SOS message to the authority.
 - b. Enable search and rescue team to locate victims.

Architecture

Figure 2 below shows the architecture of Mo-FA where it shows both modules and its relations to the user i.e the victims and rescue teams. Flood victims are able to query flood information, evacuation centers and also route to the evacuation centers to the system and the server should be able to provide flood related information and route to the center on the map. Other than that, this integrated mobile application is able to provide early warning to the public on the possible flood occurrences via SMS broadcasting sent by the server. In any emergency situation, victims are able to send their current location via eSOS message. Users or victims need to register their personal information and contact number prior to utilizing this feature. All eSOS messages with victims' detailed information as well as the current location in the format of longitude and latitude will be captured and updated in the system's database. The rescue teams or authority parties will be notified and actions will be taken accordingly following the NSC Directive No.20.

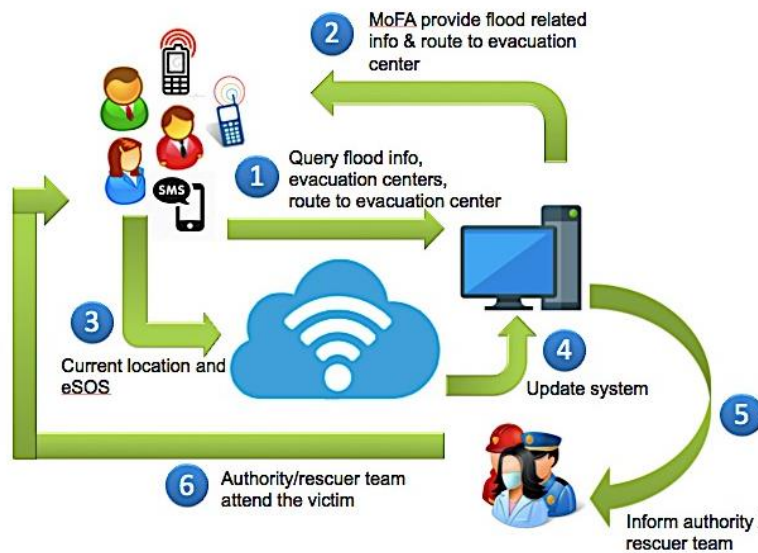


Fig-
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Mo-

Architecture

Some of the screen shots of Mo-FA are shown in Figure 3 (a) – (e) below. Figure 3(a) shows the main page once the application is launched where it shows the current weather and location of the device. Figure 3(b) shows the system menu on the features available. While Figure 3(c) and (d) show the real-time information that are obtained from two (2) main web-

sites of DID for river water level information, flood camera and recent alert (if any). eSOS page can be seen in figure 3(e) where the user can send eSOS message so that they can identified to be rescued.

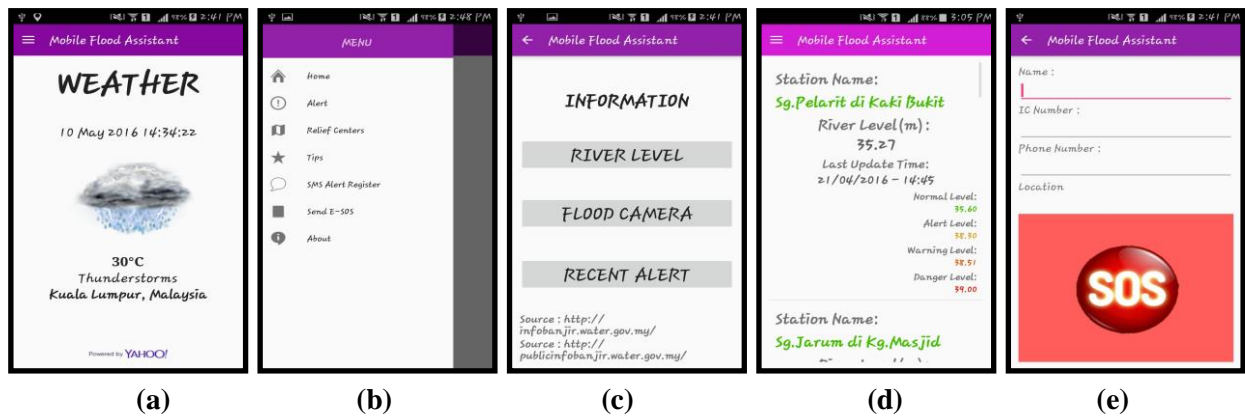


Figure 3(a) – (e). Mo-FA Screen Shot

Benefits of Mo-FA

Mo-FA was designed to meet its main objective of providing an early warning alert and facilitating in search and rescue operation. Users of this application are expected to experience the following benefits:

- The application is able to capture current weather information and location. This is very helpful during the search and rescue operation.
- The application is able to provide flood related information such as the amount of rain and river water level using the data obtained DID and MetMalaysia. The information are all real-time that are obtained from the live updates of *publicinforbanjir* and *inforbanjir*.
- The application that is able to provide early warning to the public on possible flood occurrence via SMS broadcasting. This is one of the features that current practice of disaster management in Malaysia lack of. All this while, the flood information are relayed only to the authority parties, but not to the victims.
- The application is able to provide information on the nearest evacuation centers and routes will be displayed on a map to facilitate affected victims to move to safe area. By utilizing the current technology embedded on modern mobile devices i.e the GPS, this feature is made possible.
- By taking advantage of the GPS feature, the application is able to facilitate the rescue teams to locate the victims' whereabouts upon receiving eSOS message sent by the victims.

CONCLUSION

Mo-FA is a tool developed to provide early warning for flood monitoring with reliable notification via SMS. It is also able to facilitate the rescue teams to locate the victims' whereabouts upon receiving eSOS message sent by the victims. Users to this application are expected to experience benefits where they are able to receive flood-related information such as rain fall information, river water level and also flood camera information. Users also can obtain information on the nearest evacuation centers. The evacuation centers are displayed on

a map to facilitate affected victims to move to safe area. Instructions and advices are made available as reference as well as preparation to the victims. Early warning on possible flood occurrences are obtained via SMS broadcasting. This is important to alert the victims at the early stage of flood. Finally, with the GPS feature available on the mobile phone, it gives benefit to the user where the application is able to capture current weather information and location. The location information is very useful that can facilitate the rescue teams to locate the victims' whereabouts. Since this application is able to notify both victims and rescue teams, thus this application has potential to avert or minimize economic and social losses.

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