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Research paper



RESQ Banjir: a Mobile Apps for Emergency Rescue, Evacuation and Relief Center Management

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Abstract

A quick response to urgent relief needs after a natural disaster is vital to the alleviation of a disaster's impact in the affected areas. Flood victims had difficulties in sending emergency relief requests as they had limited phone battery life to highlight their current location. Such limitation led to the difficulty in locating the victims, which affected the effectiveness of coordinating a rescue and evacuation operation. In this research, we develop ResQ Banjir application which consists of Flood Rescue & Evacuation Operation Management (FREOM) and Flood Relief Centre Management (FRCM) to assist in flood disaster management. In these system, we exploits the existing and emerging technologies on smart phones and tablet such as sensors, cameras, GPS, SMS, Location Based System (LBS) and Augmented Reality (AR). The FREOM system is a web and mobile apps based system consist of the Rescue & Evacuation Management System (server) for rescue and evacuation operation monitoring & management at the flood operation center; SOS/SMS Flood apps for sending SOS help by victims; ResQ Banjir Skuad Penyelamat apps which is used by rescue teams to locate and rescue flood victims, and an Augmented Reality (AR) guidance system for location direction navigation guide. FRCM is a web based system which integrates a number of features such as flood relief center registry, shelter activation and management, inventory management and disbursement, and relief aid and goods supplies management. We conducted a simulation testing that involves the overall capability of the applications. Both systems seem to be working in an efficient manner although there are some issues that exist.

Keywords: *Augmented reality guidance; Disaster relief management; Flood mobile apps; Flood relief center management; Flood rescue and evacuation operation management.*

1. Introduction

In December 2014, a devastating flood hit a number of states within Malaysia such as Sarawak, Sabah, Perak, Pahang, Kelantan and Terengganu. The flooding disasters that occurred in these locations have caused severe damage and even claimed the life of a number of victims. As such, quick disaster response for relief needs after such disaster is vital to alleviate a disaster's impact in the affected areas. In Malaysia, the management of disaster is executed through the committee system aptly called The Disaster Management and Relief Committee [1]. This system is established at all levels (federal, state or district) respectively, based on the nature of the emergency situations. The system focuses on organizing and mobilizing seven main agencies, which would carry out specific tasks in the event of a disaster [1]. However, even with the existing ICT infrastructure, such platforms are not fully utilized in all current phases of disaster management activities. This situation has led the Flood Disaster Management (FDM) to be ineffective and inefficient which impacts the Flood Relief Center Management (FRCM) and Flood Rescue & Evacuation Operation Management (FREOM) as well. Such situation has affected most of the relief and evacuation activities especially during the recent flood disaster in 2014. There were a number of situations that was handled poorly such as relief supply distribution and even monitoring victim registration [6]. But, one of the main issues faced during a disaster especially for the SOS notification is the difficulties that victims faced in sending emergency requests from their current location due to infrastructure failure. Such limitation has led to the difficulty in locating the victims and coordinating the required rescue operation with the rescue teams [5], [6], [9].

In order to overcome such limitation, a suitable infrastructure is required to receive requests and allocate suitable rescue teams based on the victim's location. Without a central mechanism, the overall SOS notification process is made ineffective and inefficient. Rescue teams are solely dependent on social media and other communication platforms such as Twitter and WhatsApp to organize rescue efforts [5]. As such platforms rely on a stable internet connection, victims rescue request are often sporadically received by the rescue teams. As part of our research for the ResQ Banjir architecture, we proposed an Android-based mobile application aptly called SOS Banjir that would be utilized by the rescue teams. The SOS notification application utilizes a Location based System, GPS, compass and SMS technology which is available on most mobile devices. This overcomes the necessity of a stable internet connection during a disaster. Hence, the application could support the rescue efforts and emergency response activities during a disaster in an efficient manner.

This paper initially highlights the inefficiencies that are commonly faced by rescue teams during a disaster. Secondly, the system design of the SOS Banjir is examined in relation to the ResQ Banjir architecture. Thirdly, the initial testing results conducted on the application are discussed. Finally, our conclusion as well as

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related future work for the proposed application system is also highlighted.

2. Inefficiency Occurrences During Rescue Activities

Quick response time is essential in any emergency relief activity especially after a natural disaster. This ensures that the victims within the affected areas could be rescued in a timely manner. However, during the recent Malaysian flood disaster, the rescue activity was solely coordinated via WhatsApp which was not efficient and effective as all rescue requests are sent to a number of rescue teams at the same time. Such situations promoted a duplication of requests which incidentally confuses the rescue teams and slows the overall rescue activities. Besides that, the victims themselves had difficulty in sending rescue request as they may have limited connectivity to explain in length their current location. Locating the victims and coordinating rescue operation is also made more difficult due to the challenge in tracking the positions of rescue teams during the disaster. It is essential for the positions of rescue teams to be tracked as it allows a more effective usage of available rescue resources.

Both of the issues in sending rescue requests and coordinating rescue operations among the rescue teams stem from the failure of existing communication infrastructure such as mobile networks [9], [10]. The 2014 Malaysian flood disaster highlighted that the only infrastructure that could be utilized in a relatively stable manner during a disaster is the GPS and SMS technology (SmsBanjir). Furthermore, there may be an interruption in the electricity supply that would require the use of portable devices to assist in managing such situations during a disaster. The flood disaster that occurred in 2014 mainly highlighted that the use of mobile devices was sufficient to organize rescue efforts albeit slightly disorganized (SmsBanjir).

A reliable and centralized ICT rescue system and application could enable better decision making by providing essential information to the Rescue Coordinator / Centre on the current rescue requests via these two stable infrastructure. Furthermore, the rescue system would make the task of mobilizing rescue teams based on their current position to the victims more quick and effective. By utilizing tablets and smartphones that consume less electrical power and supports the two stable infrastructure, rescue efforts are more structured.

3. RESQ Banjir System Design

Our proposed mobile application is developed on the Android platform as the existing number of users for the platform exceeds other available mobile platforms [7]. The ResQ Banjir System consists of two major sections, which are 1) the Flood Relief Center Management (FRCM), and 2) the Flood Rescue & Evacuation Operation Management (FREOM). The system exploits the existing and emerging technologies that can be utilized immediately with the cooperation of local authorities and mobile network providers through the use of smart phones and tablet. The new generation of mobile phones is equipped with sensors, cameras, and GPS capabilities and has more processing power and larger screens capable of displaying images, maps, or videos, etc. Using Location Based System (LBS) and Augmented Reality (AR) technologies delivered via mobile phones will be a valuable, and cost-effective that allows flood victims and rescuers much need. Timely information with real time data and e-services will enhance the efficiency and effectiveness of Flood Relief Center Management. In this paper, we are mainly focusing on the SOS Banjir mobile application architecture which is part of the Flood Rescue & Evacuation Operation Management system.

Figure 1 depicts the overall system architecture for the Flood Rescue & Evacuation Operation Management (FREOM) that works in tandem with the SOS Banjir application (highlighted in the box):

3.1. Flood Rescue & Evacuation Operation Management

The system module consists of the following functions:

1. Support rescue and evacuation activities
2. Flood victims are able to alert rescue and evacuation center their gps position via sms (show on osm map)
3. Tracking of rescue unit position (show on osm map)
4. Tracking of rescue vehicles position (show on osm map)
5. Direction and distance guide using ar and smart phone compass technology
6. Navigation guide
7. Database of flood information and point of interest (poi) which will be display on the map.
8. Coordinates rescue and evacuation operation.

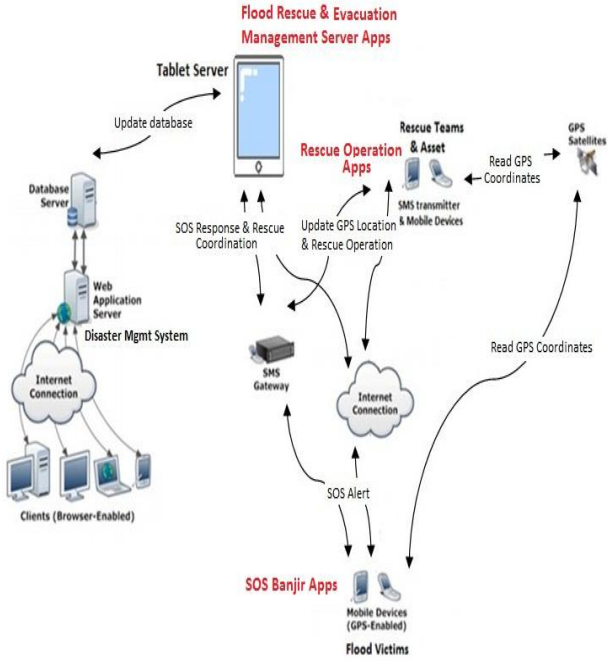

Fig. 1: The system architecture for the Flood Rescue & Evacuation Operation Management

The system's mapping component utilizes the Waze libraries. The libraries is shown to be capable of showing an overall map of the flood affected area, provide additional map information such as POI (point of interests), favorite points and access to specified places in the area. The system can also provide compass support and navigation guide to the identified places. For tracking the flood victims, a victim can send an SOS alert via their Subscriber Identity Module (SIM) card number as its identity, along with other data such as their GPS coordinates and message to the SOS Banjir server using a mobile phone. The SOS Banjir application provides two alternative connections for the user to use depending on the available communication channels: mobile-internet or SMS. The position of the victims could be displayed via the Waze API map, or in a standard tabular view. The tracking of the rescue team and support vehicles could be supported via a SMS transmitter kit with a power bank backup.

3.2. SOS Banjir Architecture

The SOS Banjir mobile application consists of a number of components such as an SMS-center, database and a web administrator

platform. Below are the relevant programming languages utilized for each of the components:

1. Web admin: The web admin is based on the Windows server Operating system and we use C# and ASP.net (windows-based)
2. SMS-Centre: The API provided by SMS center is based on PHP and an Apache server with PHP language are needed to handle the SMS management system.
3. DATABASE: The database used is MySQL base on Linux. The MySQL server and Apache server are installed in the same server as web admin. By handling the port setting, we opened a port for each server to be working all in one physical machine. The database used in Android version is SQL-Lite to store the victims rescued statistic data in the officer android device.
4. Physical Machine server: A PC Server which is installed with VMware OS is used in this project for the installation of Resqbanjir FREOM system project server which is in Windows and Resqbanjir FRCM system project server which is in Linux (Ubuntu), both in the same machine. Each server has its virtual machine and working isolated from other server in same device.
5. Apps FREOM rescue officer: This apps is for the rescue team which it is based on Android and programmed with Java in android studio.

Figure 2 depicts the overall process that the SOS Banjir application goes through upon receiving an SOS request from a victim.

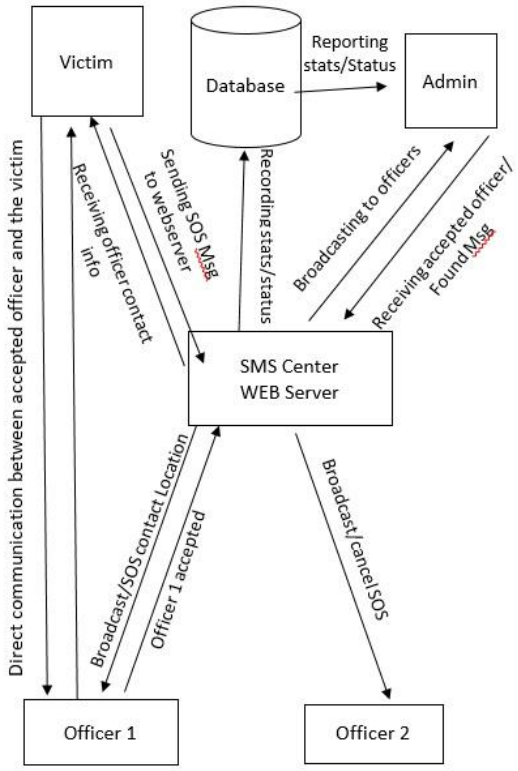

Fig. 2: Overall process when utilizing the SOS Banjir application

The SOS request is initially sent to a specified Webserver via the SOS application. The Webserver that handles these re-quests has two operating modes: a) Auto-pilot (decision made based on the server) or b) Manual (an admin controlled decision). Once the request reaches the Webserver, the request either could be sent to all available rescue teams (auto-pilot) or the admin manually selects which rescue team which is suitable to proceed with the requests. Within the Administrator panel, there are three lists that could be seen. The first list is the SOS requests received which is clickable and shows the location of SOS request and any available rescue teams within the area. The second list highlights the available rescue officers that could be selected if they are closer to the victim. The last list shows the on-going rescue activities information such as the victim's name, their designated rescue officer, the status of the rescue operation and the current time-stamp.

When a rescue officer receives the SOS request, they have an option either to accept the request or to allow another officer to accept it. If more than one person chooses the request, then the Webserver will automatically decide based on the fastest response time between the officers. Once that has been decided, the Webserver would send a cancelled SOS request message to the other officers who accepted the request. This cancelled SOS request message is essential as the request would be listed in all of the officers' who initially accepted request until the Webserver selects the suitable rescue officer. The system then would automatically remove the request from the other officers' rescue listings. An administrator can also monitor the list of on-going rescue activities and they are able to contact the rescue officers directly if needed.

Once the rescue officer accepts the SOS request, the Webserver then sends the officer's contact information such as their name and contact number to the victim to establish a direct communication between the rescue officer and the victim. The officer would also be provided with victim's details as well. Once the victim is found, the officer could change the status of the rescue activity to 'Found' in order to update the Webserver of the current rescue activity status. Information such as the number of victims rescued and their gender would be captured by the officer into the application. This update could also be monitored by the administrator via the on-going res-cue activities list panel. When the rescue officer safely sends the victim to a relief center, they would be able to update the Webserver by filling up a form which details the relief center location and the time of arrival. This information would then be up-dated in the server database and could be seen when a report is generated by the administrator.

In order to better support the rescue mission, we proposed the utilization of both GPS and Augmented Reality (AR) technology that could be found in current mobile devices. This application can help the rescue team and associates for better tracking the flood victims. This application will show the direction and distance of the target object. Besides that, it can also provide information about the target object. At the same time, the flood victims can use this application to find the nearest rescue centers and other point of interest (landmarks) around them.

3.3. Flood Relief Center Management (FRCM)

The FRCM consists of the following functions:

1. Registration – relief center, staffs, volunteers, victims
2. Relief Aid and Goods Supplies
3. Asset, Resource and Inventory
4. Relief and Human Resource Request
5. Shelter Activation and Management
6. Information and resource sharing between relief center
7. Dashboard info

For the development of Relief Centre Management application, we developed it based on the Sahana system architecture and database design [8]. This would enable the application to be integrated with the Sahana architecture especially for wide data sharing between centers. The Flood Relief Centre Management application is a standalone decentralized management system. The data entered into the tablet will be sent/updated to the database server of Disaster Management System at the state or national level whenever internet service is available. This intermittent updates will allow a centralized data collection about existing relief centers to be collected. The data collection enables an effective coordination of the relief operation at a higher management level. Within this application, an application Info dashboard would be developed that allow users to get real time information about the relief centers such as statistical information, current needs and more. The application would also allow users to input information about the flood or response to the needs of the relief center. These

information will be updated to the application through the Application server. The architecture of the application is shown in Figure 3.

Our application is capable to operate on mobile devices such as smartphones and tablets which are more suitable for most rescue and evacuation operations. Most of the current mobile devices are equipped with higher processing power as well as longer battery capacities. For our application, we are implementing a number of features such as the Location Based System (LBS), GPS, SMS, compass and Augmented Reality (AR) to enhance both, the rescue and evacuation operations as well as the management of relief ceters.

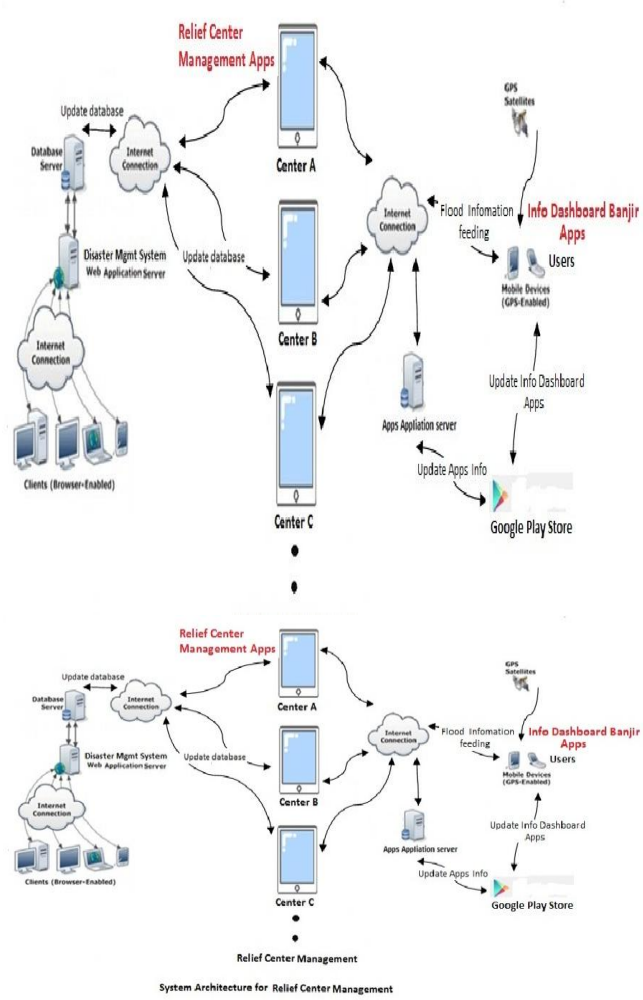

Fig. 3: The system architecture for the Relief Centre Management

The proposed system could be utilized immediately with the co-operation of the local authorities and mobile network providers as their existing architecture would play a major role for our system. As highlighted in the earlier section, the Sahana Eden platform is an effective system for the management of disaster reliefs. In addition, the platform is an Open Source platform and could be customized according to our needs. The modules within the platform are represented by a number of tables in the database. All of the tables are normalized as below:

1. All agencies providing facilities such as shelters or warehouses to store inventory are grouped under Organizations
2. All types of people including staff of agencies, volunteers, victims are subclasses of Person
3. There can be various types of groups of People. Family is a special kind of group of people
4. Shelters and victims can request for supplies of item and the response can come from any Warehouse inventory

As such, we have decided to integrate the platform into our proposed system to increase the overall usage as well as lowering the cost of implementation for our system.

4. How the Overall System Works

The two systems (FREOM and FRCM) work in tandem during a rescue and evacuation operation. As shown in Figure 4, the victims could send an SOS for help via SMS that is received by the FREOM system. The system then indicates the nearest rescue team to the victim and identifies the suitable team for the current operation. The central operation center would then send a notification on the location of the victim as well as the instruction to proceed with the rescue operation.

The FREOM system would also send a notification to the victim by providing the status of the rescue operation such as estimated arrival time and vehicle type. During the rescue operations, the devices utilized by the rescue teams would send intermit-tent location notifications to the FREOM system that enables the operation center to track the team's locations at any given time. Such tracking capability would enable a more efficient rescue operation to be executed based on the victim's location.

Once the rescue team arrives at the victim's location, they could trigger a safety notification to the FREOM system. The FRCM system would then notify the rescue team the location of the closest shelter that could receive the victims.

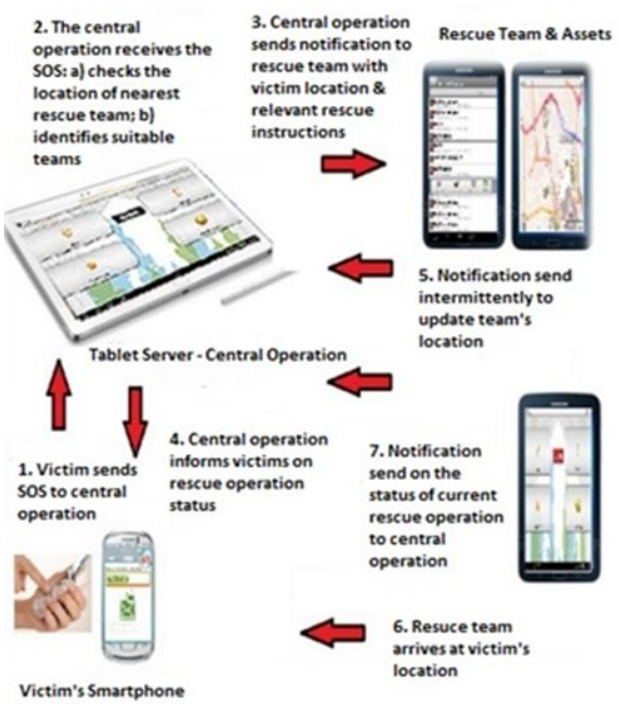

Fig. 4: The operational flow of the ResQ Banjir system

The system identifies the shelters based on relevant information such as available space and necessary resources that would allow sufficient assistance to be provided to the victims upon arrival to the center. Such information would mitigate the issue of overflowing rescue centers and low food / medical supplies that may affect the wellbeing of the rescued victims.

5. Conclusion

It is predicted that there will be a positive impact on the effectiveness and efficiency of rescue operation during flood with the implementation of the proposed ResQ Banjir apps. With the use of SMS, GPS and Augmented Reality (AR) technology on smart phones; locating victims and tracking rescue teams will speed up

the rescue and evacuation operations; besides improving the coordination of the rescue and relief efforts.
The Relief Center Management apps could enhance the operations of the center. With the use of ICT, related decision making processes would be more effective as various information such as the status of relief centers and surrounding areas could be updated in real-time to various rescue agencies and to the public. With the support of the system, most of the issues faced by Relief Center Management such as shortage of food, waters and medical supplies, crowded evacuation centers and inaccurate information could be mitigated or even solved.

Acknowledgement

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