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Disaster Mitigation Management Using Geofencing in Indonesia

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***Abstract*—Disaster mitigation is defined as activities to reduce the loss of life and assets. The information technology (IT) grows rapidly and brings benefits and values to human such as automating processes, gaining efficiency and effectivity, helping human in solving problems, and taking decision. In this research, we propose the used of IT such as mobile technology, geofencing technique, and also communication technology such as the concept of smartphone ad hoc networks (SPANs), and Optimized Link State Routing (OLSR) Protocol to ensure the information about disaster mitigation in the disaster-prone area spread widely. This finding aims to enhance local community and tourists awareness, spread the whole information about disaster mitigation, and help the government to evaluate, direct, and monitor the disaster mitigation, and accommodate less delayed communication while the disaster occurs.**

Keywords-–Disaster mitigation; smartphone; mobile technology; geofencing; SPANs, OLSR.

I. INTRODUCTION

Disaster mitigation is one of approach to decrease the risk of disaster. Disaster mitigation aims to anticipate the disaster occurrence, and also to decrease the number of victims. The mechanism of disaster mitigation can be done before the disaster happens by developing the disaster-resistant building or gaining the awareness and the enhancement of people's ability in facing the disaster[1][2].

When the disaster occurs, people will confuse and panic. In this situation, people tend to do unstructured actions towards self-rescue[3][4]. This condition will be worse for tourists who are not familiar with that areas. However, the government seems not present in that moment.

The chaos while the disaster occurs is the common event in Indonesia. It caused by the lack of accommodation which is pointed to well-organized and massive information dissemination. The information is often spread by using spread board and website. According to this experience, the development of mobile-based mitigation system is proposed. The proposed system is engaged geofencing technique in order to notify and monitor every people who entry and exit the disaster-prone area.

The other research has been discussed the disaster mitigation information system by using geofencing [5]. It presented the application which enabled the monitoring of people who are in the disaster-prone area. Unfortunately, it did not add the feature of alert, information of disaster mitigation standards, map of areas, collaboration, etc. Whereas, the information sharing and collaboration can improve the situational awareness [6]. It is also not engaged the government as monitor, and also policy and compliance organizer. Moreover, it is just focused on local people.

Meanwhile, this research presents some important points of improvement. The mobile-based information system does not only act as monitoring application but it also acts as information and knowledge source for users. It provides the disaster mitigation standards, mitigation routes, safe points, emergency standard solutions, collaboration by using local chat, and panic button. Moreover, it does not only focus on local people but it also notifies the tourists who come to the disaster-prone areas to set up the disaster mitigation information system on their smartphone.

Disaster tends to cause infrastructure damage which in turn will affect communication process in disaster area. In this situation, we need an infrastructure which enables smartphone to communicate without cellular network. Some researches proposed MANET as solution for communication problem in this situation [7][8]. In this research, we proposed smartphone ad hoc networks (SPANs) as a framework to implement MANET in order to create a local network in disaster area. SPANs provide a dynamic infrastructure to connect smartphones for knowledge sharing purpose in disaster area. OLSR is used as a routing protocol in this proposed disaster mitigation system. OLSR provide a more effective way to transmit information and ensure network availability in disaster area [9].

By conducting this research, there will be a solution towards the problem about the lack of disaster mitigation information, alert, and poor communication channel and network.

II. LITERATURE REVIEW

This part describes the base of knowledge which is used towards the research. In this part, disaster mitigation, geofencing theories, and recommended communication infrastructure to support the system is discussed.

A. Disaster Mitigation

Disaster mitigation is defined as a set of activities to reduce the risk of disasters by building the physical disaster resistant building, socialization to increase the residents' awareness, and the enhancement of capability against disaster. According to Ministerial of Indonesia Regulation No. 33 2006

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about disaster mitigation, there are four important points in disaster mitigation such as:

- The availability and the map of disaster-prone areas
- The socialization towards the enhancement of knowledge and awareness of disasters
- The knowledge about things to do and prevent, and also how to be safe
- The management and governance of disaster-prone area to reduce the disasters

This research aims to generate the technology to facilitate the four points above. First, it enables the availability and the map of disaster-prone areas. Secondly, it will help the government to spread the information towards the enhancement of knowledge and awareness of disasters. Third, the technology also enables the users to get the knowledge about things to do, standardized emergency actions, things to prevent, safe points, and how to reach the safe points when the disaster occurs. Finally, even though this technology cannot directly reduce the disasters but, as it accommodates the knowledge and information, it may help in reducing the risk of loss.

B. The recent study for IT-Based Disaster Mitigation

IT has been growing rapidly. It helps human to reach the goal or even replace human to do something. Pertaining the disaster mitigation, IT can be engaged such as [10]

- The use of sensors, editable website, the data mining application to catch, analyze, and spread the lesson-learned
- The use of database, website, call center technology in order to provide the information about equipment, volunteers, and material.
- The use of planning, scheduling, task allocation, and resource management applications to formulate the disaster management plan and track down the execution.
- Deploy the cell phone technology to provide a standalone communication in emergency situation where all local infrastructure is down.

In this research, we build a mobile-based disaster mitigation information system. This system aims to provide information about the mitigation routes, safe points, standardized emergency actions, etc.

C. Geofencing Technique

Geofencing is known as virtual fence on specified location [11]. It is originally referred to a practice of limiting mobile users to a specific geographic location by tracking their whereabouts via GPS [12]. It combines awareness of the user's current location with awareness of the user's proximity to location that may be of interest [13]. Geofencing can be used to test whether a presence inside the fence is true or not in order to trigger some sort of action [14]. The fence around a physical location is known as geofence. Figure 1 shows the visualization of geofence technique simulated in Palembang, South Sumatra, Indonesia.

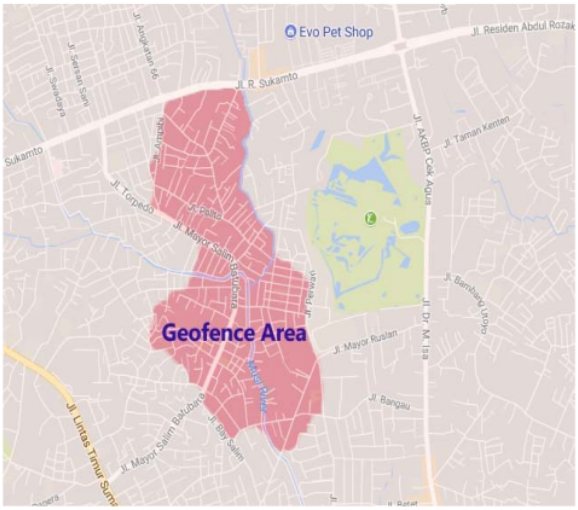

Fig 1 The geofence area in Palembang, South Sumatra, Indonesia

There are some research applied geofencing in disaster management. Dipesh et al develop an android based application using geofencing known as D-Fencing for disaster management [15]. D-Fencing can be used as a mean of communication in a post-disaster situation. Another approach which combined geofencing technology and social network platform for disaster management is proposed by Szczytowski [16]. This approach using geofencing to group users into a dedicated disaster communication group based on their location. The implementation of social network features allows user in a service group to exchange real-time information, coordinate rescue efforts, issue and report tasks.

D. Mobile Ad-Hoc Network

A mobile ad hoc network (MANET), also known as wireless ad hoc network, is a mobile device connected wirelessly with continuously self-configuring in the infrastructure-less network. This network has a dynamic topology due to nodes enter and leave the network continuously. On the other hand, means that there is no fixed infrastructure to support the network configuration or no centralized control [17]. the Illustration of this network shown in figure 2.

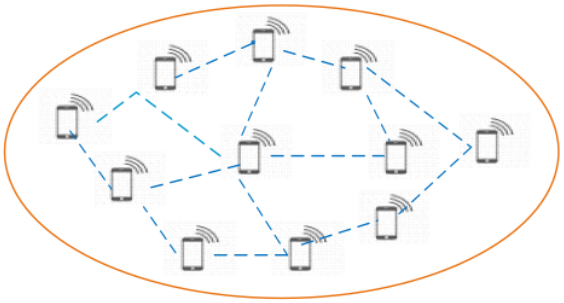

Fig 2. Illustration of the infrastructure-less network (MANET-Mobile ad hoc network).

Herewith some of these scenarios that valuable to use for MANET, such as meeting, military communications, sensor networks, Emergency or disaster relief situations and so on.

E. Smart Phone Ad hoc Networks (SPANs)

Nowadays, most of people use smartphone for any purposes such as for communication, entertainment, business, etc. There are two popular smartphone operating systems (OS); Android and iOS. Due to the vast popularity of Android devices, porting Optimized Link State Routing (OLSR) to Android is the most logical approach to facilitate ad-hoc communication[18].

Smart Phone Ad-hoc Networks (SPANs) is an open source framework which utilizes MANET technology to provide a resilient backup framework for communication between users when all the infrastructure cannot be provided [19]. MANET based solution is a headless, infrastructure-less network that enables common smartphones to connect together in a non-static way.

The routing protocols are the true cornerstone of the MANET architecture as they adopt the network for scalability, mobility and power constraints of mobile devices[19]. OLSR Protocol is built for mobile ad hoc networks [9]. OLSR aims to minimize duplicate retransmission in the same region [20] with the use of multipoint relays (MPR). Proactive nature in OLSR also ensures the routes are always immediately available when needed [9]. OLSR works best in large and dense mobile networks [18].

III. THE PROPOSED MODEL FOR DISASTER MITIGATION

The proposed model is engaging mobile technology and geofencing technique. The geofencing technique has been widely used as a feature of software application which uses the global positioning system (GPS) to set up the geographical boundaries. In this research, the geofencing technique allows the government as administrator to define the trigger. Whenever the device enters or exits the virtual fence which has been set up by admin, there will be a notification to the system.

First, the administrator must define the boundaries. In this research, the boundaries are the disaster-prone areas. When the persons come to the area there will be a short message sent to the person to download the mobile-based disaster mitigation information system. The mobile-based disaster mitigation information system allows the government to monitor every people in the disaster-prone areas. Once the application downloaded, the application will also download the area map, mitigation routes, the information about the areas, and safe points.

The mobile-based disaster mitigation information system is also featured the panic button, which allows the user to send the emergency alert to safe and rescue (SAR) team. Moreover, the system is also allowed the user to detect the current location and the nearest safe point. This feature leads the user to directly move from current location to nearest safe point. Figure 3 shows the notification when the disaster occurs. Meanwhile, in Figure 4, the mitigation route to nearest safe point is presented.

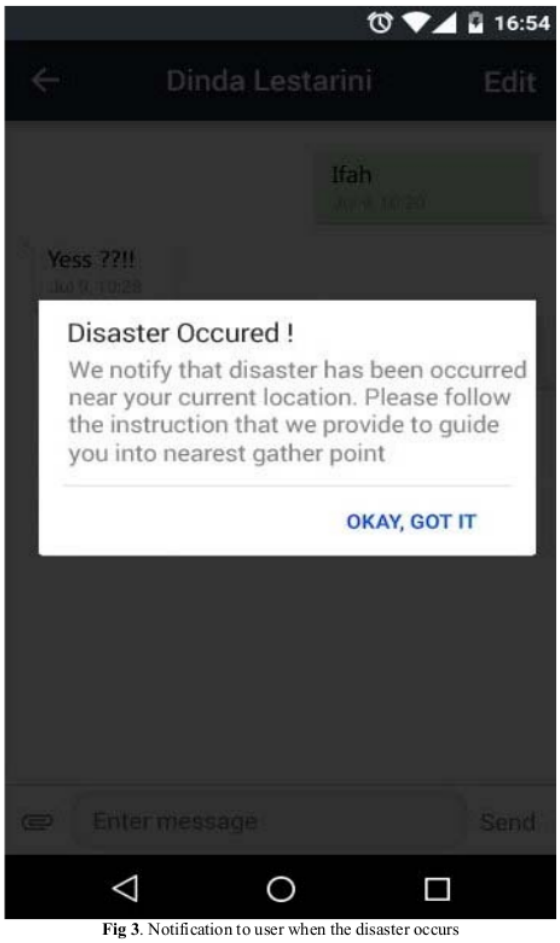

Fig 3. Notification to user when the disaster occurs

Due to a possibility of infrastructure damage in disaster area, we suggest the use of SPANs to accommodate the communication in the emergency situation. SPANs is used as a local communication channel in a geofenced area. SPANs enable communication from device to device through wireless connection. This mechanism will help to disseminate information in disaster area where there is no internet connection.

OLSR protocol will route the information transmission link proactively. When a person requests information from system, the request will be forwarded to an MPR. MPRs are a set of selected nodes which will retransmit and collected the information. The information will be relayed to the next MPR until it reaches the base station. The base station in this model serves as gateway which will connect the local connection with internet. It is also able to share the information to smartphone using the same mechanism. Information from the base station will be relayed through MPR until it reaches smartphone.

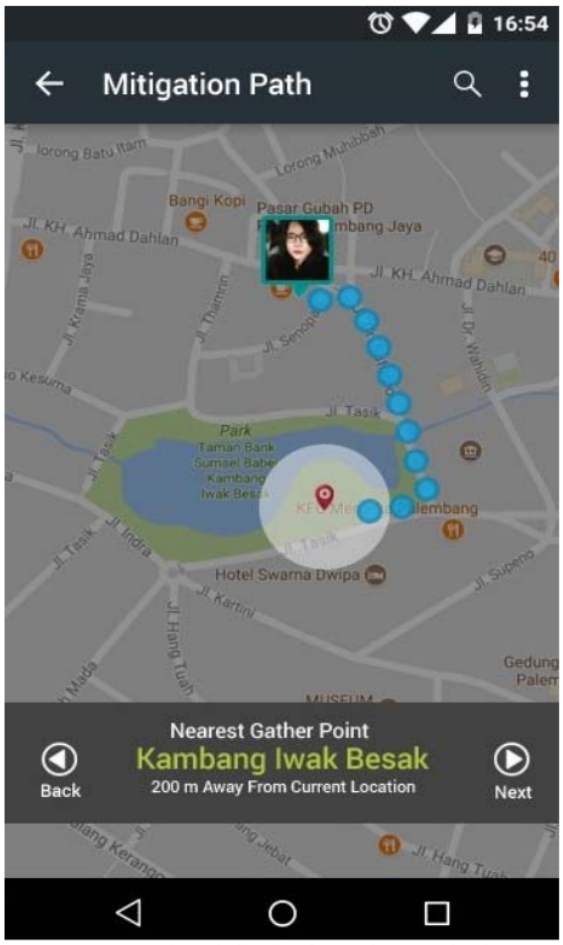

Fig 4. System shows the location of user and nearest safe point

IV. CONCLUSION

The importance to find the more effective technology to help the disaster mitigation has been spoken. As the IT has been increasingly used to fully-automated the processes, This paper has presented an overview of a proposed IT-based approached for disaster mitigation in Indonesia by using geofencing and MANET to achieve the goal of making better results based on more realistic models for various disaster scenarios. By conducting this research, there will be solution for more effective and efficient way to spread information, direct, and monitor community in disaster-prone areas. In the further research, the performance measurement of the proposed design in this research will be presented.

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