MISSIONS: The Mobile-Based Disaster Mitigation System in Indonesia

IOP Conf. Series: Journal of Physics: Conf. Series **1007** (2018) 012033 doi:10.1088/1742-6596/1007/1/012033

MISSIONS: The Mobile-Based Disaster Mitigation System in Indonesia

Rossi Passarella[1], Sarifah Putri Raflesia[1*], Dinda Lestarini[1], Ahmad Rifai[1], Harumi Veny[2]

[1]Faculty of Computer Science, Universitas Sriwijaya, Jl. Raya Palembang-Prabumulih Km. 32, Indralaya, South Sumatra, Indonesia
[2]Faculty of Engineering, UniversitiTeknologi MARA, Shah Alam, Selangor, Malaysia

E-mail: *syarifahpr@gmail.com

Abstract. Disaster mitigation is essential to minimize the effects of disasters. Indonesia is one of the disaster prone areas in Asia and the government explores the usage of Information technology (IT) to aid its mitigation efforts. Currently, there are Indonesian websites which hold information regarding the weather monitoring, climate conditions, and geophysics. But, there is no clear indicator of mitigation efforts or things to do during an emergency. Therefore, this research proposed MISSIONS, a disaster mitigation model using geo-fencing technique to detect the location of the users through their mobile devices. MISSIONS uses mobile-based disaster mitigation system as a way to disseminate critical information to victims during emergency when they are in disaster zones using virtual fences. It aims to help the government to reduce the effects of disaster and aid in the mitigation efforts. The implementation result shows that MISSIONS have a high accuracy in detecting user whereabouts.

1. Introduction

Natural disasters occur at several places around the world and they can happen at any time and at any place. These natural disasters are very common in regions that are claimed as disaster-prone areas. Indonesia is a classic example of a disaster-prone area in the world. The occurrence of natural disasters cannot be predicted accurately[1] and hence the adverse effects on the society and the economy are enormous[2]. Therefore, efforts should be taken in order to mitigate natural disasters. Disaster mitigation could be defined as a set of activities that are carried out to lessen the likelihood of a disaster or to diminish the prevalent risks of disasters if the disaster itself cannot be avoided[3]. Disaster mitigation activities which are done by the government organizations aim to minimize the risk of disasters by decreasing the loss of human and animal lives and loss of property or wealth. The government organization in Indonesia which deals with disasters is Indonesian Agency Disaster Mitigation or BadanNasionalPenanggulanganBencanaAlam (BNPB).

According to BNPB, the most frequent disaster in Indonesia between 1815 and 2016 were flood and tornado but the deadliest disaster was none other than the earthquake. The earthquake has been rightly termed as the deadliest disaster because it has taken the lives of over 57% of the total victims. The main reason for such a high percentage of loss is the lack ofdisaster-related information dissemination [4][5].The people found it difficult to identify any evacuation route and there was no information on safe places at those moments.Hence, there must be a system to accommodate the

problem of lack information indisaster mitigation especially during the disasters occur. The system can be used to send alerts and also information about evacuation whenever the disaster occurs. The studies about disaster mitigation which finally generated the innovation to support disaster mitigation have been done all over the world such as the use of drone technology to find survival in the disaster area[6], remote sensing technology to assess the damage caused by the disaster [7], social media to communicate[8], disseminate disaster-related information[9] and map resources[10] in disaster area, data mining to predict the natural disaster[11], and mobile-based technology to evacuate the survival by engaging the geo-fencing technique[12]. In order to develop a system which could be used for disaster mitigation, this research proposes an Information Technology (IT) model by using the geo-fencing technique.

Geo-fencing can be defined as an innovative technique based on telematics and satellite positioning that aims to demarcate a boundary or a virtual fence in a specified geographic area[13]. The geo-fencing technique was developed around the year 2000 in order to track the list of devices entering a particular virtual fence or geographical space[14]. From the time of its development, geo-fencing has been primarily used for tracking purposes, such as tracking trucks, buses, or human beings. Geo-fencing is popularly used in the logistics sector to enable the stakeholders to trace the location of trucks[13]. In the recent times, geo-fencing is being used increasingly in other dimensions, especially in rescue and support operations. In 2016, a model for child safety was proposed where the model enables the parents to monitor the children safety in real time[14] [15].The geo-fencing technique also empowered for health field. It is embedded into wearable device to monitor the persons with Alzheimer's and dementia.

For the first time, in 2015, an application used geo-fencing technique for human protection in disaster management. This application for human protection during disaster management was named HelpMe and it enables the rescuers to discover the locations of disaster victims[16]. According to the previous findings[16], the geo-fencing has been used for supporting IT-based disaster mitigation. Unfortunately, the proposed technology is focused on monitoring the people who have been familiar with the environment. There's no early notification for new people such as tourists, people who arrive for business, etc. Hence, in this research, the improvement of model is adding the early notification for newcomers. In this research, this geo-fencing technique is embedded in the system which is named MISSIONS in order to maximize the efficiency and effectiveness of disaster mitigation activities. MISSIONSprovides disaster mitigation maps, information, regulation, and emergency plans. Meanwhile, the use of geo-fence enabled MISSIONS to track the people trapped in the disaster area. Then, it sends emergency notification to users and instructions for survival such as the nearest safe point and possible evacuation routes.

There are two important lessons that lead to effective mitigation in natural disaster. First, we must consider disaster as unresolved problems which are unpredictable, isolated and independent events. The second lesson is the mitigation process cannot depend only upon technological solutions, it also should be based on others measures, such as engineering devices, land management, social regulation and economic improvement [17]. In order to fulfill the requirements of mitigation processes, the proposed model also includes the IT regulations and governance as a control. It is mandatory to engage IT governance and government regulations so as to ensure that the use of the proposed system aligns with the action plans and strategies formed by the government.

2. Overview of Disaster Mitigation in Indonesia

The importance of disaster mitigation in disaster-prone areas can be seen from those countries' Government Regulations and policies to handle disasters. One such example is the Indonesian Government Regulation No. 33 (2006). It states the availability of information regarding disaster-prone areas and the types of disasters in Indonesia should be made known to the public. The government regulation goes on to encourage socialization among people living in these areas in order to increase the level of social awareness regarding these issues. The people should also know what

they should do and not during critical situations. Finally, the government regulation also insisted on the importance of governance and the role of Indonesian government in the mitigation of disasters.

Disasters often happen in Indonesia such as earthquake, landslides, flood, and tsunami. It is caused by the geography factors where Indonesia is located. According to Indonesian Government Regulation No. 33 (2006), the keys of disaster mitigation are:

- the availability of disaster-prone areas information and maps;
- the information dissemination about disaster mitigation to enhance the knowledge and awareness of disaster mitigation;
- ensure that all people in disaster-prone areas aware of things to do and things that must be avoided;
- re-organize and rearrangement of disaster-prone areas.

Nowadays, Indonesia spread the information about disaster in the official website Indonesian Agency Disaster Mitigation which means all the people must pro-actively to check the website to get information about disaster. According to the requirement of information dissemination in disaster-prone areas in Indonesia, this paper proposed disaster mitigation model which includes MISSIONS, the mobile-based disaster mitigation

3. The Proposed Model: IT-Based Disaster Mitigation

The proposed disaster mitigation model using geo-fencing technique is applied through the development of MISSIONS which is controlled by well-prepared IT governance and government regulations. The aim of this model is also to support the four keys important of disaster mitigation according to Indonesian regulation. The flow chart of the activities in MISSIONS is depicted in Figure 1.

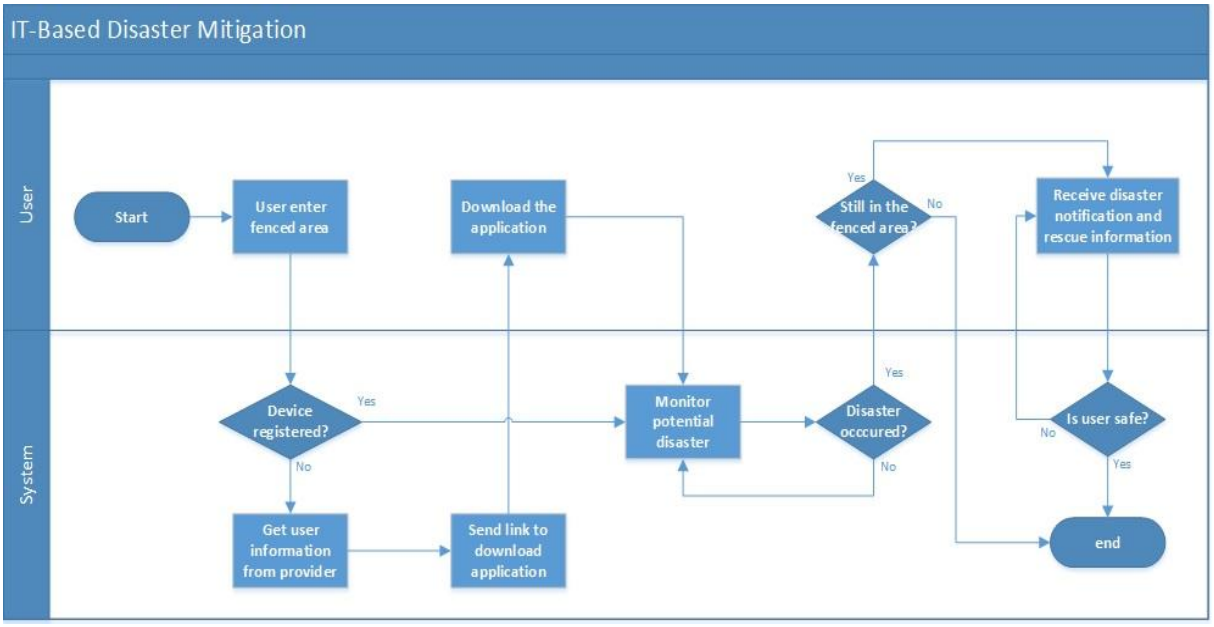

Figure 1. Flowchart of MISSIONS.

First, the geo-fence will be set up around the disaster-prone areas by person in charge. The person in charge can be staff of Indonesian Agency Disaster Mitigation. When users enter the virtual fence, the system will check whether the user is registered or not. If the user is not registered, system sends the short message service (SMS) with a link to download MISSIONS for disaster mitigation and register users' devices. Once the device registered and the users are still in the virtual fence, MISSIONS will be able to send the location of users to the server. It will help the rescuers to trace the location of users.

MISSIONS will proactively monitor potential disaster in the disaster-prone area. Moreover, it also provides the set of standards operation of disaster mitigation, safe points, emergency contacts, important places (hospital, police stations, etc). This feature aims to support the well-spread knowledge about disaster mitigation. Figure 2 shows the MISSIONS presented the current location of user and the nearest safe point.

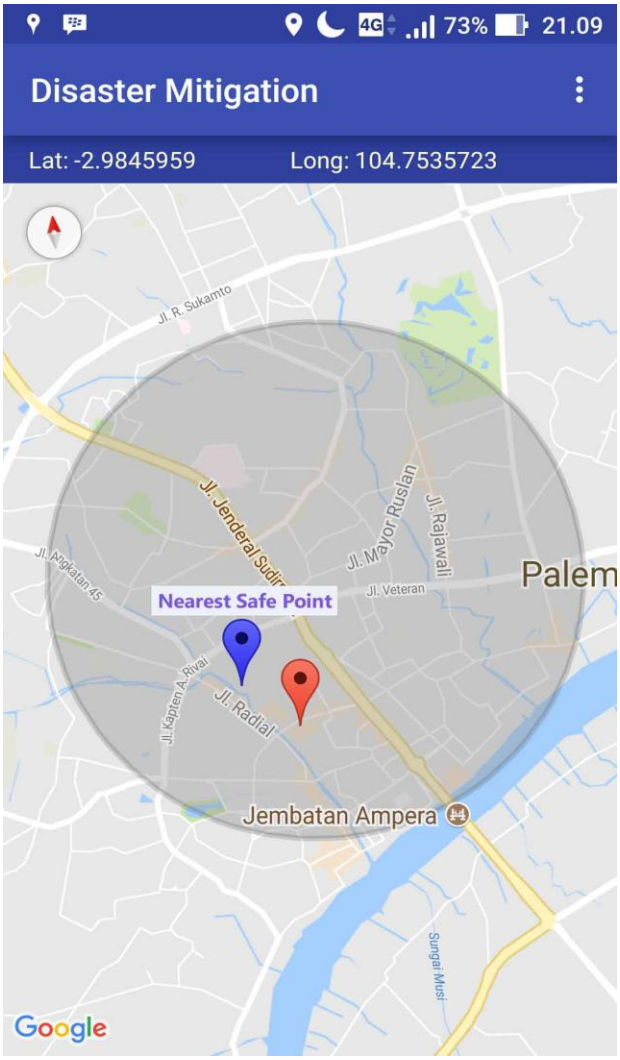

Figure 2.MISSIONS during its operation shows the current location and nearest safe point.

As we mentioned in the previous part that there are four important keys to the disaster mitigation. MISSIONS accommodates directly to the first three keys; as the maps and mitigation routes provider; support the information dissemination and spreading the standardized operations of disaster mitigation. Pertaining the early diffusion of MISSIONS, the model is also supported by traditional approach which means during the process of awareness enhancement by using MISSIONS, the government must also provide the face-to-face meeting to the people in the disaster-prone area, information boards, and spreading information by using mass media.

Meanwhile, when disaster occurs, the system automatically sends notifications to the users in fenced area. The notification will also include rescue plans, such as the nearest evacuation routes and the meeting points. By using the MISSIONS, the users will also be able to send emergency messages. The user can also communicate with rescuers to guide them to the safe zone. In this situation, if the

users exit the fence, MISSIONS stops to communicate with the users, understanding that they are in the safe zone. Besides engaging the MISSIONS for disaster mitigation, the proposed model includes the government regulations and IT regulations and governance.

4. Missions Evaluation

This evaluation part aims to show how the MISSIONS works in detecting and monitoring people in disaster-prone area. For the evaluation process, the virtual fence was created as the representation of disaster-prone area. This area was in radius 4 kilometers. In order to evaluate the MISSIONS, the scenario was the user had to enter and exit the disaster-prone area which was previously configured by system administrator. While the user in the disaster-prone area, the user was notified, monitored, and provided with disaster information such as rescue plan, safe points, things to do in emergency situation, etc. Table 1 shows the result of this evaluation.

Table 1. MISSIONS Evaluation Result.

Number of Experiments	Entered Fence (meters)	Exited Fence (meters)
1	32	33
2	37	42
3	25	26
4	42	45
5	33	37
6	32	31
7	42	43
8	38	39
9	36	39
10	33	33

The evaluation result depends on the internet connection and Global Positioning System (GPS) accuracy. According to the evaluation, the MISSIONS sent notification that the users entered a disaster-prone area when they were about 25-42 meters inside the fence. The average distance for entry notification is 35 meters. Users also received notification that they are in safe area when they were about 26-45 meter outside the fence by means the average distance for exit notification is 36.8 meters. According to the evaluation results, MISSIONS has a high accuracy in detecting user location when they entered or exited the fence.

5. Conclusion

Disaster mitigation activities are necessary to protect valuable lives and assets of the country. Indonesia is one of the disaster prone areas in Asia where it is prone to earthquakes, floods, landslides and so on. With the increasing use of IT in all fields, this research explores the use of IT in disaster mitigation. Consequently, a disaster mitigation model using geo-fencing technique has been proposed in this research. This model includes the proposal for development of a MISSIONS using geo-fencing technique with adherence to IT governance and regulations of the country. This proposed model would magnify the efforts of disaster mitigation and when operationalized, the performance measurements will help in the betterment of the model. The implementation of MISSIONS shows that users will entry notification when they are about 35 meters inside the fence. The users will also get the notification when they are about 36.8 meters outside the fence. This result shows that MISSIONS have a high accuracy in detecting the location of users.

References

[1] Arceneaux K, and Stein R.M. 2006 Who is held responsible when disaster strikes? the atribution of responsibility for a natural disaster in urban election. *Int. J. of Urban Affairs* 28 pp. 43-53

[2] Butt S 2014 *Asia-Pacific Disaster Management: Comparative and Socio-Legal Perspectives* ed S Butt, HNasu and L Nottage (Berlin: Springer Berlin Heidelberg) pp 183-196
[3] Whybark D C 2015 Co-creation of improved quality in disaster response and recovery.*Int. J. Qual. Innov*. 13
[4] CFE-DMHA 2015 *Indonesia disaster management reference handbook*
[5] Mileti D.S., and Brien, P.W.O. 2014 Warnings during disaster : normalizing communicated risk. *Soc. Problem* 39 pp 40-57
[6] Lee S, Har D, and Kum D 2016 *Proc. APWC on CSE/APWCE 2016* ed A B M S Ali, M A Khan andK Mamun (Nadi: Conference Pubishing Services) pp 84-89
[7] Radhika S, Tamura Y, and Matsui M 2016 Application of remote sensing images for natural disaster mitigation using wavelet based pattern recognition analysis. *Int. Geosci. Remote Sens. Symp*., pp. 84–87
[8] Velev D. and Zlateva P 2012 *Int. Proc. Econ. Dev. Res*., 8 pp. 41–45
[9] Funayama T 2015 *Proc. Int. Con. on ICT and Knowledge Engineering*(Bangkok : Siam University) pp. 42–45
[10] Basu M, Ghosh S, Jana A, Bandyopadhyay S, and Singh R 2017Resource mapping during a natural disaster: A case study on the 2015 Nepal earthquake.*Int. J. Disaster Risk Reduct.,* 24 pp. 24–31
[11] Refonaa J, Lakshmi M, and Vivek V 2015 *Proc. Int. Conf. on Circuit, Power and ComputingTechnologies*(Tamilnadu : the Institute of Electrical and Electronics Engineers, Inc) pp. 1-6
[12] Suyama A and Inoue U 2016 *Proc. Int. Con. on Computer and Information Science*
[13] Reclus F and Drouard K 2009 *Proc. Int. Con. on Intelligent Transport SystemsTelecommunications* pp 353-356
[14] Munson J P and Gupta V K 2002 *Proc. 2nd Int. Work. Mob. Commer*. - WMC 02 40-44
[15] Raflesia S.P, Lestarini D, Taufiqurrahman, and Firdaus, 2017 *Proc. Int. Con. on Electrical Engineering and Computer Science* pp. 160–162
[16] Yelne S and Kapade V 2015 Human protection with the disaster management using an android application. *Int. J. of Scientific Research in Science, Engineering and Technology* 5 pp. 15-19
[17] El-Masri S and Tipple G 2002 Natural disaster, mitigation and sustainability: the case of developing countries. *Int. Plan. Stud.,* 7 pp. 157–175

Acknowledgement
We would like to thank Lembaga Penelitian Universitas Sriwijaya for the funding the research by rewarding grant Hibah Kompetitif 2017.