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Improving the Effectiveness of the Dissemination Method in Disaster Early Warning Messages

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Abstract. The dissemination of disaster early warning messages has a significant role in the effectiveness and serviceability in an Early Warning System (EWS). Providing the community in a disaster area with an adequate dissemination and communication of early warning messages will improve people's awareness and reaction to a natural hazard. People who live in a disaster area play a crucial role in the success of EWS. Malaysian, Sri Lankan, Bangladeshi and Indonesian authorities employ mobile phone applications, such as text messages (SMS), as a tool for disaster warning messages. However, there are many challenges in methods for disseminating early warning messages. One of the challenges is the dissemination method in which only notification messages are sent. In this paper, we propose *confirmation* or *verification* messages, as part of disaster early warning messages, by using text messages. Confirmation messages are messages that use a verification channel to provide up-to-date official information about the latest natural disaster conditions.

Keywords: disaster management, early warning messages dissemination, SMS

INTRODUCTION

Warning messages dissemination in the Early Warning System (EWS) is one of the essential services that can save many people to avoid becoming a victim of disaster. The warning messages dissemination process is a linking between information about the current situation and conditions and the people who live in the disaster area. Receiving the right and factual information about both predicted and current conditions, will make significant advantages for people to make the right decisions to mitigate the impact of the disaster. It can be said the right information can save many lives.

In recent years, numerous warning message methods have been used in many countries. For instance, SMS in Malaysia (Khalid & Shafiai, 2015), Indonesia (Windarto, 2010), Bangladesh (Bhuiyan et al, 20153) ; Facebook and twitter in Indonesia (Anggunia & Kumaralalita, 2014). In addition, previous studies in alert or warning messages (Kesper 2007; Ayobami & Rabi'u 2012; Ismail & Husen 2013: Keoduangsine, S. et al 2014: Hellriegel & Klafft 2014) have shown that is preferable to use a notification or announcement to give information to people in the disaster areas.

Despite various forms of disaster early warning messages, the effectiveness and serviceability of disaster warning messages is still far from being able to increase people's awareness and response to the hazard. The authority provides the warning messages, but it seems that the warning messages are not adequately targeted to the people who live in the disaster area. (UN/ISDR, 2006). The effectiveness of EWS will be determined by the process of the warning messages dissemination.

The approach presented in this paper builds on the context of the problem related to the alert and warning messages in EWS. This paper looks the EWS's classification model and the warnings' characteristics in EWS. Section three explores the challenges of using notification warning messages. In section four a proposed approach for improving the effectiveness of the method for disseminating early warning messages is outlined.

CLASSIFICATION

This section clarifies the importance of dissemination method for disaster early warning messages as a part of the EWS.

Classification in EWS

The United Nations Inter-Agency Secretariat of the International Strategy for Disaster Reduction UN/ISDR (2006) made the classification for EWS based on actions. The actions should be done by the authorities and community to handle the preparation for a disaster. There are four actions in EWS according to the UN/ISDR's checklist. The first action is related to 'risk knowledge'. Risk Knowledge is about predicting the risk and making the risk knowledge a resource for predicting further disaster. The second action is related to the 'monitoring and warning service'. Monitoring is observing and forecasting hazards. The warning service provides information from the analysis of the disaster's monitoring. The third action in the UN/ISDR's checklist is about 'dissemination and communication' of the hazard's information. The fourth relates to the 'response capability' of the community to handle the hazard.

Differing from the UN/ISDR's EWS classification, the United Nations Asia and Pacific Training for Information and Communication Technology/ APCICT (2010) categorized EWS based on the ICT's functionality. APCICT classify EWS into two groups. The first group has the function of forecasting, mapping, monitoring and modeling. This group provides output of predictions; models or maps that can help the authorities or decision makers in Government or non-Government handle the disaster. The second group provides the dissemination and communication. This group broadcasts the warning messages and provides the communication channels.

From the point of view of system engineering, Meissen and Voisard (2008) suggest dividing the EWS into four layers. The first layer is the monitoring and data collection. The second layer is the information processing from the warning monitoring. The third layer generates the warning messages for the different user group. The fourth layer is the alert dissemination. It is interesting in the Meissen and Voisard (2008) EWS model, that the model distinguishes between alert and warning messages layers. However, Meissen and Voisard (2008) did not include the communication process in the EWS layer.

By recognizing, the EWS classification, it is certain the dissemination process of alert and warning messages becomes a vital section , and it should be included in the checklist

group or layer when building and using EWS. The communication becomes a challenging part when it is related to the dissemination process of the warning messages.

This paper looks at the dissemination process to enhance the effectiveness of EWS. The reason is that in the models in UN/ISDR (2006); APCICT (2010) and Meissen and Voisard (2008) there is no discussion or explanation about the dissemination process and method of disaster early warning messages.

Characteristics of Warnings in EWS

The characteristics of the warnings are based on actions. These categories clearly define the definitions of the warning messages and point to the tools and media that can be used for the warnings in EWS.

The first action for warning in EWS is to attract people's attention. The tool for providing the alert is commonly using a siren or loud sound. This tool is the easiest and fastest media to disturb and attract people's attention. However, this tool usually does not give any information about the disaster. It can make people question the reason for the siren and loud sound and become confused. In addition, people tend to panic, and it ends with chaos. It is suggested, that using a loud sound or siren will need regular training or additional information. (Mahmud et al 2012; Proulx & Sime 1991). However, regular training for using alerts and sounds to warn people in disaster area gives rise to another challenges, people tend to forget the training. In addition, some countries (particularly in developing countries) consider that regular training will add some additional cost and time. (Mahmud et al., 2012)

The second action is warning messages. The aim is to provide more information about current disaster situation. It is an extended alert. The media that is usually used is short text messages (SMS) (Aziz et al, 2008), Cell-Broadcast (CB) (Aloudat & Michael, 2011) or using the Internet services such as email, web page or messenger applications. Warning messages can be sent many times dependent on the hazard condition. It is useful because people do not become confused or panic because of the hazard situation.

Based on the actions of warnings in EWS, their characteristics can be categorized as alert and warning messages. An alert message is better for attracting people's attention compared with warning messages. Warning messages provide more information about the current situation of the disaster. Furthermore, the warning message prepares people to become more aware of the possible emergence of natural hazards in the environment where they live.

Understanding the characteristics of the type of messages in EWS, it is obvious that most of the messages are about announcements and notifications to attract people attention. It is correct to issue alert and warning messages to increase people's awareness about the current situation.

However, the notification or announcement related to alert and warning messages in EWS will create new problems for handling the preparation for a disaster.

PROBLEMS WITH USING NOTIFICATIONS AND ANNOUNCEMENTS IN ALERT OR WARNING MESSAGES.

The first problem is the weakness of using an alert or sound to distract and attract people's attention. People tend not to know what is happening and what should done in

an emergency situation. (Proulx & Sime, 1991). It could trigger chaos or panic in society. Furthermore, people try to phone or call the authorities to seek verification about the alert (Samarajiva & Waidyanatha, 2009). So, the alert in EWS becomes inefficient.

The second problem is validating hoax warning messages. Many hoax messages spread after an alert disseminates. This, too, can cause people to panic and create chaos in an emergency situation. Such as a lesson was learned, when a wrong alert sounded in Aceh for a tsunami in 2006 (Kesper, 2007), hoax messages were spread for the tsunami in Mentawai October 2010; when Mount Merapi, erupted in November 2010; the earthquake and tsunami in Jakarta in 2010 and 2011, and a tropical storm that would hit Jakarta in February 2012 (BNPB, 2015). Hoax messages render disaster early warning messages ineffective as a way to alert and warn people.

The third problem is regarding unofficial warning messages or 'Multiplication phenomenon'. The multiplication phenomenon is the unofficial warning messages, which are disseminated by people who have received the official warning and then tell others. Previous studies about the multiplication phenomenon explain that the multiplier, like a neighbour, also can influence the dissemination process of disaster warning messages. (Hellriegel & Klafft 2014; Nagarajan et al 2010) That study does not explain the positive or negative assessment of the 'multiplication phenomenon'. It can be useful if the warning message is from a known and reliable sources that receiver is knows and trusts. However, it can turn out to be a problem if the warning message is out of date or contains false information. It is clear that there are problems using notification and announcements in alert or warning messages.

ENHANCING THE EFFECTIVENESS OF EARLY DISASTER WARNING MESSAGES USING SMS

Our approach for improving the effectiveness the dissemination process of early disaster warning is based on the problems that have been identified in notifications and announcements in alert or warning messages. It is important that the approach we propose for improving the effectiveness of the dissemination process for these messages is user or community oriented. As the early warning messages should target local geographic areas, we propose the use of SMS. We also consider the organizational (government and non-Government) as the official resources for the early disaster warning messages.

Push and Pull SMS Method

In an SMS application on a mobile phone, information can be received and sent, commonly known as Push and Pull SMS method. (Rumpa 2005 cited in Peevers et al., 2008)

The Push messages method is a notification message, which automatically received by the user. The Push method message means a user will always receive the messages. The Push method has been widely used in the field of e-banking, e-government, e-commerce and warning messages in EWS. The Push method is already used a lot in e-banking, e-government and e-commerce. In e-banking, the user of the Push method is an individual user. The aim in e-banking is for a security layer when the user is using internet banking. (Peevers et al., 2008). Differing from e-banking's Push method, the e-government target

of the user is a group. (Susanto et al., 2008). In an e-commerce application, the Push messages method is similar to the e-government but it is applied as a commercial advertisement (Zhang & Mao, 2008)

Pull messages method is based on the user initiative. The user requests information by sending a particular character or number to get the information. Similar to the Push method, the Pull method is in use in e-banking and e-government sectors. In e-banking, the Pull method is user initiated for security verification or authentication in a banking transaction. It is to enhance the security of e-banking (Peevers, 2010). In e-government, the application of the Pull messages method is an alternative to searching for information (Susanto et al., 2008).

This proposed model of using the Push and Pull methods via SMS will enhance the effectiveness of disaster warning messages by enabling prompt and targeted messages to a local area as well as providing a way for people in that area to receive up-to-date information.

Model For Disseminating Early Disaster Warning Messages Using SMS

Notification Early Disaster Warning Messages Method

The notification early disaster warning message method is a Push messages method whereby warning messages will be automatically received by the user and will always receive the messages. The Push messages method uses an event application or 'broadcast location'. In the context of disaster warning messages, the Push method will be valuable as extended alert messages, where the target user is usually person or community who lives in the disaster area. The notification warning message in EWS' context has identical information comprising an announcement. The target user for the notification warning messages method is a group of people.

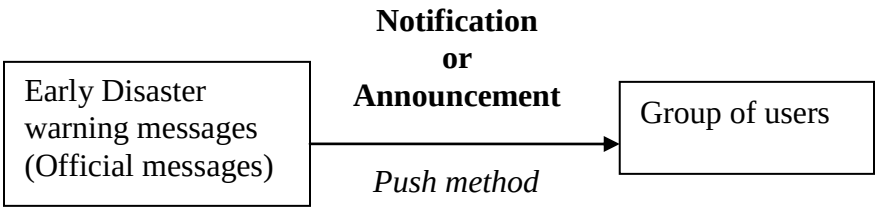

FIGURE 1. Notification early disaster warning messages for group of users.

Next, we add a channel to search for a situation update of the disaster information. This channel is the confirmation warning messages method. The aim is to handle problems with notification warning messages, such as hoax messages and multiplication phenomenon messages.

Confirmation Early Disaster Warning Messages Method

The Pull method function in disaster warning messages is for confirmation messages. Using the confirmation messages method can reduce the problems with the notification

messages method in disaster warning messages. In addition, the Pull method's function as confirmation messages provides an alternative to the public to search for information or confirmation from the authorities. The target user for the Pull SMS method is an individual.

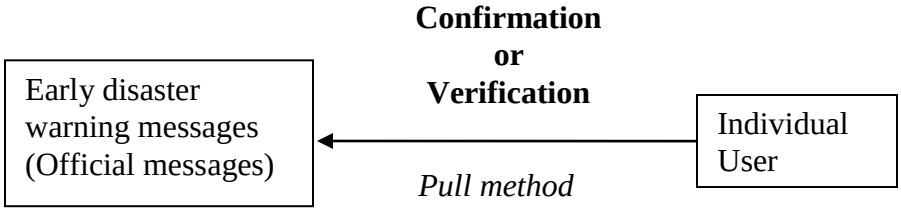

FIGURE 2. Confirmation early disaster warning messages method based on the user initiative for confirming or verifying the notification early disaster messages that the individual user received.

CONCLUSION AND FUTURE WORK.

In this paper, we presented an approach using SMS dissemination method for enhancing the effectiveness of a disseminating method for early disaster warning messages. The model that we propose is still using notification early disaster warning messages as a priority to disseminate notification and announcement messages.

However, due to many challenges in methods for using notification in disseminating early warning messages, we add *confirmation* early disaster warning messages. The reason for adding the confirmation early disaster warning messages method in the dissemination process is to provide up-to-date official information about the latest disaster situation. The confirmation early disaster warning messages method is based on the user's initiation using the Pull SMS method.

Future work will involve a formative evaluation to investigate community perceptions of the effectiveness and serviceability of using SMS for disaster warning messages. In addition, this model for using notification and confirmation messages will be tested and evaluated as a summative assessment to measure the effectiveness and serviceability of SMS delivered early disaster warning messages.

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REFERENCES

1. Aloudat, A., & Michael, K. (2011). *The application of location based services in national emergency warning systems: SMS, cell broadcast services and beyond*. University of Wollongong

2. Anggunia, S. D., & Kumaralalita, L. (2014). *How Indonesians Use ICT and Social Media for Disaster Management.* Retrieved 29 August, 2014, from http://discover.isif.asia/2014/03/how-indonesians-use-ict-and-social-media-for-disaster-management/
3. Asia and Pacific Training for Information and Communication Technology APCICT. (2010). *ICT for Disaster Risk Reduction* ICTD Case Study 2, Republic of Korea: Asian and Pacific Training Centre for Information and Communication Technology for Development. Retrieved 15 January, 2015, from http://www.preventionweb.net/files/14338_14338ICTDCaseStudy21.pdf.
4. Ayobami, A. S., & Rabi'u, S. (2012). *SMS as a Rural Disaster Notification System in Malaysia: A Feasibility Study*. Proceedings of Third International Conference on Communication and Media (i-COME), Penang, Malaysia.
5. Abdul Aziz, I., Hamizan, I. A., Samiha Haron, N., & Mehat, M. (2008). Cooperative flood detection using GSMD via SMS. In Information Technology, 2008. ITSim 2008. International Symposium on (Vol. 3, pp. 1-7). IEEE.
6. Badan Nasional Penanggulanan Bencana (BNPB). (2015*,). Jangan Sebarkan Info Bencana Hoax*. Retrieved 23 March, 2015, from http://jogja.solopos.com/baca/2012/04/28/bnpb-jangan-sebarkan-info-bencana-hoax-181794
7. Hellriegel, J., & Klafft, M. (2014). *A Tool for the Simulation of Alert Message Propagation in the General Population*. Proceedings of the Eleventh International Crisis Response and Management (ISCRAM) Conference – University Park, Pennsylvania, USA, S.R. Hiltz, M.S. Pfaff, L. Plotnick, and P.C. Shih, eds.
8. Ismail, S., & Husen, M. N. (2013). *Improving information dissemination and collective data directory for focus group via web based system and SMS*. Proceedings of the Seventh International Conference on Ubiquitous Information Management and Communication, Kota Kinabalu, Malaysia.
9. Kesper, A. (2007). *Warning Dissemination Technologies for Tsunami Early Warning in Local Communities*. In Capacity Building in Local Communities Indonesia: German–Indonesian Cooperation for Tsunami Early Warning System.
10. Khalid, M. S. B., & Shafiai, S. B. (2015). *Flood Disaster Management in Malaysia: An Evaluation of the Effectiveness Flood Delivery System*. International Journal of Social Science and Humanity, 5(4), pp. 399-402.
11. Mahmud, I., Akter, J., & Rawshon, S. (2012). *SMS based disaster alert system in developing countries: A usability analysis*. Internation Journal of Multidisciplinary Management Studies, 2(4).
12. Meissen, U., & Voisard, A. (2008). *Increasing the effectiveness of early warning via context-aware alerting.* Proceedings of the Fifth International Conference, on Information Systems for Crisis Response and Management (ISCRAM) Conference – Washington, DC, USA, F. Fiedrich and B. Van de Walle, eds
13. Nagarajan, M., Shaw, D., & Albores, P. (2010). *Informal dissemination scenarios and the effectiveness of evacuation warning dissemination of households — A Simulation study.* Procedia Engineering, 3(0), pp. 139-152. doi: http://dx.doi.org/10.1016/j.proeng.2010.07.014

14. Peevers, G., Douglas, G., & Jack, M. A. (2008). *A usability comparison of three alternative message formats for an SMS banking service*. International Journal of Human-Computer Studies, 66(2), pp. 113-123.
15. Peevers, G. J. (2010). *Usability design of Short Message Service (SMS) mobile phone banking*. The University of Edinburgh
16. Proulx, G., & Sime, J. D. (1991). *To prevent 'panic' in an underground emergency: why not tell people the truth.* Fire Safety Science-Proceedings of the Third International Symposium. London: Elsevier Applied Science.
17. Samarajiva, R., & Waidyanatha, N. (2009). *Two complementary mobile technologies for disaster warning*. info, 11(2), pp. 58-65.
18. Saysoth, K, Goodwin, R., & Gardner-Stephen, P. (2014). *A Study of an SMS-Based Flood Warning System for Flood Risk Areas in Laos*.
19. Susanto, T., Goodwin, R., & Calder, P. (2008). *A Six-Level Model of SMS-based E-government.* International Conference on E-Government (ICEG).
20. Bhuiyan,T., Mahmud I. M., & Banassri Alam. (2013). *Usability Analysis of SMS alert Sytem for immunization in the context of Bangladesh*.
21. United Nations Inter-Agency Secretariat of the International Strategy for Disaster Reduction UN/ISDR. (2006). *Global Survey of Early Warning Systems*, ISDR Platform for the Promotion of Early Warning PPEW. Bonn (Germany)
22. Windarto, J. (2010). *Flood Early Warning System Develop at Garang River Semarang using Information Technology base on SMS and Web*. International Journal of Geomatics And Geosciences, 1(1), 14.
23. Zhang, J., & Mao, E. (2008). *Understanding the acceptance of mobile SMS advertising among young Chinese consumers*. Psychology & Marketing, 25(8), pp. 787-805.