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DEVELOPMENT OF EARTHQUAKE AND TSUNAMI EARLY WARNING APPLICATION BASED ON ANDROID

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ABSTRACT

Ease of accessing and using earthquake and tsunami early warning applications is a priority in this study. It is related to the more time the community prepares for disaster mitigation. The purpose of this research is to produce an Android-based earthquake and tsunami early warning application. The availability of this fast android-based earthquake and tsunami early warning application can help in quicker and more reliable earthquake and tsunami early warning for short distances to areas that have the potential to impact a tsunami. The research method used in this research is the ADDIE development method (Analysis, Design, Development, Implementation, and Evaluation. In the first year, the focus of the development of the Rapid Tsunami Early Warning Application about 4 minutes after O.T. Our previous research results, which have supported many events this application will make it easier for us to complete the prototype target. The prototype of the Android-based earthquake and Tsunami, early warning application, has been tested in real-time at the Faculty of Mathematics and Natural Sciences, Surabaya State University, Indonesia. The results of the trial have shown the eligibility requirements.

Keywords: *Earthquake and tsunami early warning application; android; earthquake; Tsunami*

1. INTRODUCTION

The most destructive Tsunami is at proximity to areas that have a tsunami impact (for example, < 1000km) from the epicenter of the earthquake, arriving within 20-30 minutes after the time the earthquake occurred (O.T.). Effective early warning at this distance requires notification in less than 10 minutes after O.T. (e.g., Tsushima et al., 2011; Newman et al., 2011; Madlazim, 2011). At present, rapid assessment of potential tsunamis from earthquakes by organizations such as the Meteorology, Climatology and Geophysics Agency (BMKG), Japan Meteorological Agency (JMA), tsunami early warning system of the German-Indonesian tsunami warning system (GITEWS) or the West Coast and Alaska (WCATWC) and Pacific (PTWC) depends mainly on the initial estimate of the location of the earthquake, the depth and moment, M0, or the corresponding moment magnitude, Mw. However, reliable Mw calculations for large earthquakes are usually provided by CMT by the strength of the moment tensor, Mw, (Extröm et al., 2005), which requires waveform inversion, varying with rupture depth, earth models and other factors, and new available 20-30 min or more after an earthquake occurred (Hayes et al., 2011; Duputel et al., 2011). So a fast magnitude estimator such as Mwp has been used for Tsunami CMT warnings, but Mwp performs poorly compared to Mw and other discriminants for tsunami potential (Lomax and Michelini, 2011A, LM2011; Madlazim, 2011).

To produce effective and efficient earthquake and tsunami early warnings, especially for short distances to areas potentially affected by tsunamis, we use the method of calculating tsunami parameters quickly. We have provided a direct procedure for measuring tsunami parameters rapidly and accurately. (Lomax and Michelini, 2009B; LM2011; Lomax and Michelini, 2011B; Madlazim, 2011; Madlazim, 2013; Madlazim et al., 2019). Measuring steps for tsunami parameters use a direct procedure that is to measure tsunami parameters from P-wave seismogram data, the dominant period Td, duration more than 50 minutes, T50Ex, rupture duration, T0. T0 for large earthquakes is mainly related to the length of the rupture, L, and both Td and T0 will increase, then the depth of rupture, z, decreases, because the effects of shear modulus and rupture speed, V_r are reduced. We have shown that the product of the multiplication duration of Td x T0 or Td x T50Ex provides more information about the impact of tsunamis than discriminating against Mw, Mwp, Mwpd (Lomax and Michelini, 2009A, LM2009A; Madlazim, 2011; Madlazim, 2013; Madlazim et al., 2019), and other discriminants that are currently used. These results indicate that the tsunami potential is not directly related to the L x W x D product of the "seismic" fault model. As assumed by the use of the Mw discriminant so far and suggests otherwise that information about the length and depth can better explain the tsunami potential from the earthquake earth. Information about the length and depth of the rupture is provided by Td x T0 and Td x T50Ex, where explicit estimates of the length and depth of the rupture are complicated and cannot be determined quickly.

The Android-based earthquake and tsunami early warning system are still undergoing development to get a more practical, more accurate, and faster earthquake and tsunami early warning system. Powerful earthquake and tsunami early warning for coastlines at a geographical distance (> 500 km) from the epicenter of the earthquake that caused the Tsunami requires notification within 15 minutes of the origin time of the quake. More recently, through the analysis of P wave (30º-90º, GCD) teleseismic seismograms, Lomax and Michelini (2009) have shown that high frequency, rupture duration, T0, greater than about 50 or T0 more top 65 (Madlazim, 2011; Madlazim, 2013 Madlazim et al., 2015) strengthens the accuracy of Tsunami early warning. Lomax and Michelini (2009) exploited this result through the direct "duration-exceedance" (D.E.) procedure applied to seismograms on GCD 10º-30º to determine quickly whether T0 for earthquakes tends to exceed 50-55 s and thus become potentially Tsunami tsunamis. Madlazim et al. (2015) implemented the Lomax and Michelini (2009) teleseismic methods to measure T0 and T50Ex (D.E.) with a threshold of 65 seconds for T0, 1 for T50Ex and 10 seconds for dominant periods (Td).

The problem in this research is how the development of earthquake and tsunami early warning applications based on android for Indonesia and surrounding areas? To develop this application, we certainly need a valid, fast, and accurate earthquake and tsunami early warning application that we have previously developed (Madlazim et al., 2019).

2. METHODS

To achieve the objectives of this study, the ADDIE model was used (Aldoobie, 2015), which consisted of 5 stages; Analysis, Design, Develop, Implementation, and Evaluation Phase. The first stage is the Analysis phase. After this stage is completed, the results are evaluated. The second stage is the design stage. After this stage is complete, the results are evaluated. The third stage is the Develop stage. After this stage is completed, the results are evaluated. The fourth stage is the Implementation stage. After this stage is completed, the results are evaluated. The fifth stage is the Evaluation stage. This Evaluation Phase is carried out for all stages.

The five stages in the ADDIE model are as follows: 1. ***Analysis Stage***; The main activity is analyzing the need for developing an Android-based earthquake and tsunami early warning application and examining the appropriateness and requirements of the application development. The problem of accuracy and speed of the implementation of earthquake and tsunami early warning that has been applied is no longer relevant to the needs of targets, technology, and availability of real-time seismogram data. 2. ***Design Stage***. At the design stage, it is an activity to design an Android-based earthquake and Tsunami early warning application development. The design of this application is still conceptual and will underlie the next development process. 3. ***Development Stage***. At the Development stage contains the activities of product design realization. Compiled conceptual framework for the application of the development of an Android-based earthquake and tsunami early warning application and realized into a product that is ready to be implemented. For example, at the design stage, the app has been designed, which is still conceptual, so at the development stage, the application is made with the device so that it is ready to be implemented. 4. ***Implementation Stage***. At this stage, the Android-based earthquake and Tsunami early warning application development is implemented in real and relevant situations, and initial evaluation is carried out to provide feedback on subsequent applications. Real-time data used to estimate earthquake and tsunami parameters are taken from data recorded by a network of local seismic stations managed by GEOFON. The process of implementing the determination of tsunami parameters uses the Jokotingkir software (Madlazim, Prastowo, and Hardy 2015). 5. ***Evaluation Stage***. At this evaluation, the stage is carried out at the process stage and the end of the activity. At the end of each stage, an evaluation is carried out, and at the end of the activity, the previous 4 stages are also evaluated. Revisions are made according to the evaluation results or needs that cannot be fulfilled by the application. The steps for developing an Android-based earthquake and tsunami early warning application are presented in the flowchart of Figure 1.

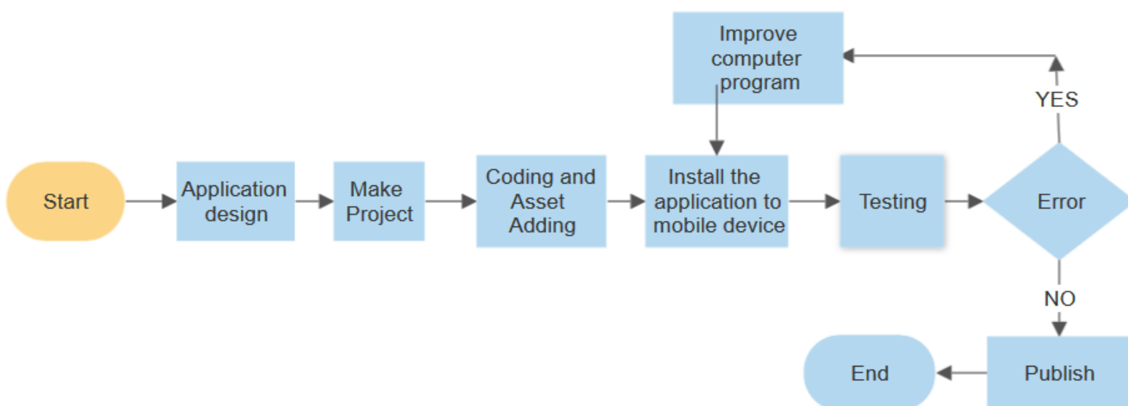

Figure 1. *Flowchart of Android-based earthquake and tsunami early warning application development.*

The application design referred to in Figure 1 above is a tsunami early warning application about 4 minutes after the web-based origin time (O.T.) earthquake that has been developed by Madlazim et al. (2019). The development of an Android-based earthquake and tsunami early warning application is a previous continuation of research.

3. RESULTS AND DISCUSSION

The results of this Android-based earthquake and Tsunami early warning application development can be divided into 2, the results of which are the development of an android-based earthquake and tsunami early warning application presented in Fig. 2. This application can be accessed downloaded and installed from the play store with Jotingkir tsunami prediction keywords or can also be directly accessed from the following website https://play.google.com/store/apps/details?id=com.smadia.prediksi_tsunami_jokotingkir.

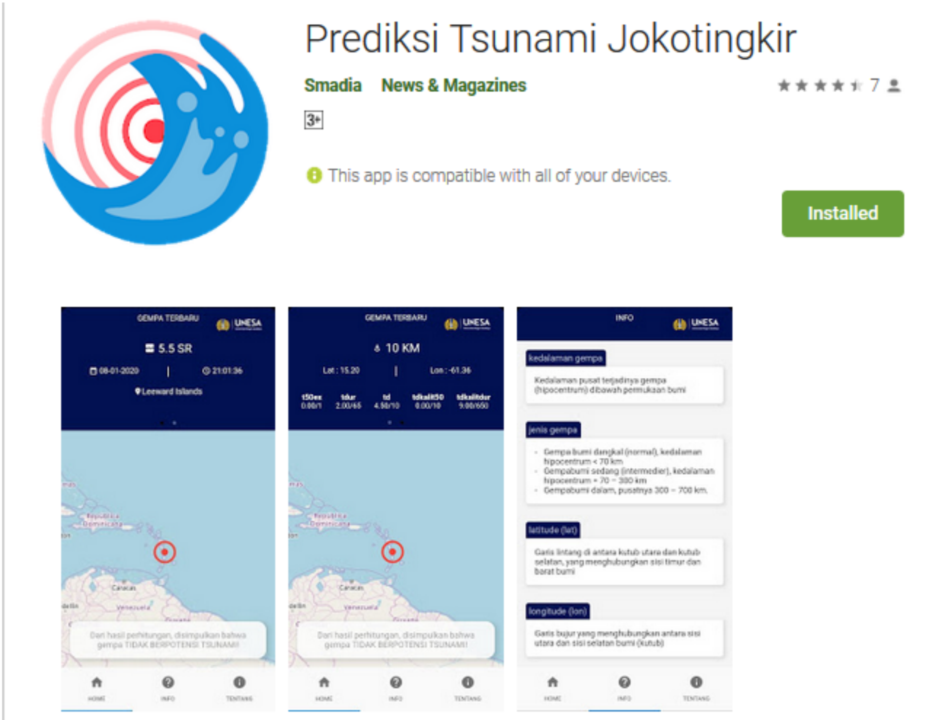

Figure 2. Android-based earthquake and tsunami early warning application.

Example of an Android-based earthquake and tsunami early warning application output as shown in Fig. 3.

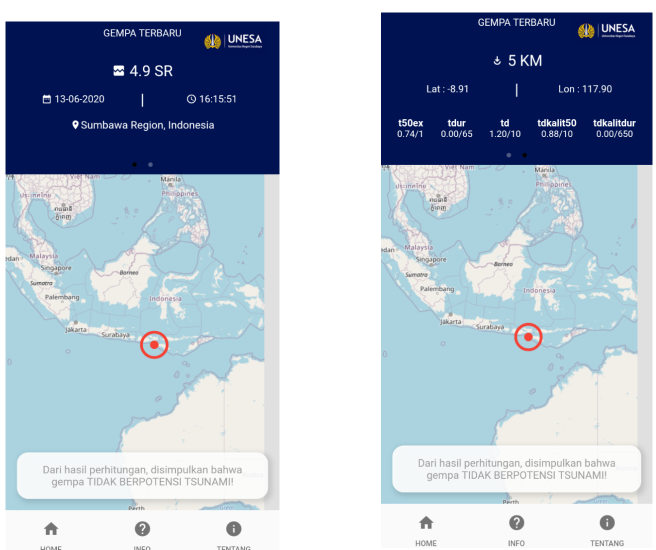

Figure 3. Example of an Android-based earthquake and tsunami early warning application output for an earthquake that occurred in the Sumbawa region, Indonesia, on June 13, 2020.

In the android-based earthquake and tsunami early warning applicatio n, as shown in Figure 2 and Figure 3, there are two pages. On the first page, there is information on earthquake magnitude, earthquake time and date, location of the region, and earthquake epicenter indicated by red dots and circles on the map. This can make it easier for users when and where an earthquake occurs and information on whether an earthquake has a potential tsunami or cannot also be read on page one or page two. Especially for Tsunami early warning, if an earthquake has a tsunami potential, then the writing of the tsunami potential that is below the map will turn red. The application icon also appears notification. On page two that can be seen by sliding the screen to the left then there will be information about the depth of latitude and longitude earthquakes and tsunami parameters (duration 50 exceed = T50ex, earthquake duration = Tdur, dominant period = Td, Tdur and T50Ex multiplication and multiplication Td and T50Ex) in numeric form. How these tsunami parameters are measured has been explained by Lomax and Michelini (2012), Madlazim et al. (2015), and Madlazim and Tjipto Prastowo (2019). On page two there is also map information and earthquake epicenter as well as information on tsunami potential or not as shown on page one. This information is made two pages with the aim that information is clear and not complicated. Based on the results of the application for the 478 most recent earthquakes used for testing the Android-based earthquake and tsunami early warning application that occurred in Indonesia and now from May 12, 2019, to June 15, 2020, with the magnitude of the earthquakes ranging from 4 to 7.5 as shown in Figure 4 and Figure 5. Of the 478 earthquakes, there were 477 earthquakes, which predicted the tsunami warning was right and there was only one earthquake that had an early warning that the Tsunami had a false warning. This application program has been improved so that in the future, it is expected that there will be no more false warnings.

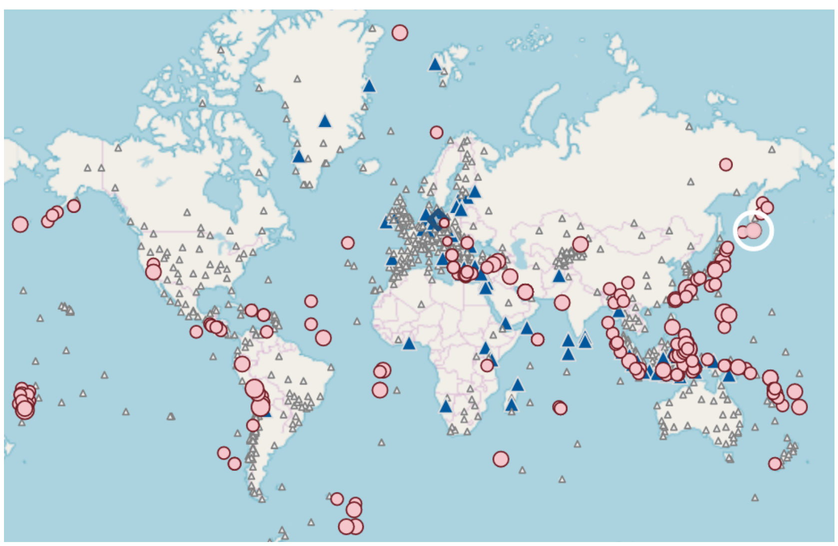

Figure 4. Attributes of the G.E. seismic network (GEOFON) that blue triangles and other than the G.E. network (small triangles) earthquake epicenter map that occurred from May 12, 2020, to June 15, 2020, which is used for testing Android-based earthquake and tsunami early warning applications.

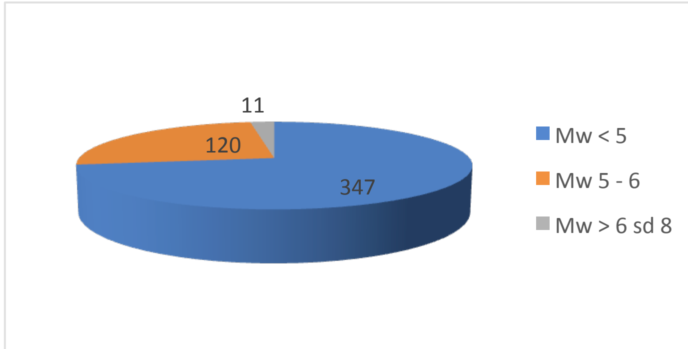

Figure 5. The magnitude of earthquakes that occurred in Indonesia and surrounding areas from May 12, 2020, to June 15, 2020, which is used for testing Android-based earthquake and tsunami early warning applications

4. CONCLUSION

Android-based earthquake and tsunami early warning applications have been developed and tested in real time using 478 earthquakes that occurred in Indonesia and its surroundings from May 12, 2020, to June 15, 20220. The results of the trials show that the application of earthquake and tsunami early warning This Android-based meets eligibility.

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