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PROFILE OF TSUNAMI EARLY WARNING SYSTEM FOR DISABILITIES: A MANIFESTATION OF THE INDONESIAN'S NATIONAL CONGRESS IN DISASTER MANAGEMENT

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ABSTRACT

The advancement of technology is projected to result in the creation of efficient tsunami detection early warning systems to aid individuals, especially those disabilities-friendly, in raising their consciousness and preparing for the worst-case disaster scenarios before they occur. This qualitative descriptive study uses data-gathering procedures based on the library research method. The numerous TEWS has been developed as an effort to recover, rehabilitate, and reconstruct and are carried out in such a way as to anticipate and prepare residents to be more alert and alert to the occurrence of tsunami. IoT based on IMU devices can be utilized as TEWS sensors with minimum limitation. IDSL information concerning elevation is highly correlated with the BIG forecast information. The Android-based received a response time of fewer than five seconds to start receiving with retrieving the tsunami and earthquake data. In conclusion, the EWS needs to be developed along with professional sign-language translators in all catastrophe knowledge as required by the National Regulation on the fundamental rights of individuals with disabilities as part of disclosing information for deaf citizens. Hence, recommendations for further research are needed to develop the TEWS integrated with VBEWS, ViBEWS, ViSEWS, and sign language.

Keywords: *Disabilities, Sign Language, Tsunami, Warning Systems.*

1. INTRODUCTION

Indonesia is one of the countries with tsunami potential because it is located on the path of meeting plates in the sea, so a large earthquake with a shallow depth will potentially cause a tsunami. Tsunami waves are mechanical waves that have a propagation speed proportional to the density of the propagation medium. In addition, tsunami waves include longitudinal waves whose vibration direction parallels their propagation. Tsunami will vibrate harmoniously in an area with an intense sea surface with a large wavelength and speed (Matsumoto et al., 2021). The energy of a tsunami wave is always constant, so when a wave enters a shallow area, its wavelength and speed will be smaller, while its amplitude will be more significant. This process can be formulated as $v=,-gd.$ (Bolin et al., 2023). Where v is the speed of the wave, g is the acceleration due to gravity, and d is the depth of the sea surface (Prahani et al., 2022). However, tsunami can be triggered by temporal el Niño and other climatic anomalies (Pararas-Carayannis & Zoll, 2017)

The tsunami waves are among the occurrences of nature, leading to one of the most devastating tragedies on Earth. However, in 2004 the Aceh tsunami was one of the biggest disasters in Indonesia (Robbe-Saule et al., 2020). Indian Ocean earthquake and tsunami its epicenter is located off the west coast of Sumatra, Indonesia (Jihad et al., 2023; Syamsidik et al., 2021; Tursina et al., 2021). The earthquake was 9.1–9.3 on the moment magnitude scale and IX on the Mercalli intensity scale. The number of victims due to the Aceh tsunami reached 167,000 people, both dead and missing. In addition, no less than 500,000 people were left homeless (Fathiah et al., 2019; Riswandi, 2023; Samphantharak, 2019). The death toll does not include tsunami victims in other regions. Other than that, Multiple devastating tsunamis and earthquakes have been recorded in the Eastern Mediterranean region throughout the last three centuries (Pararas-Carayannis, 2011). Figure 1 is a tsunami Hazard in Indonesia by Australia-Indonesia Facility for Disaster Reduction (AIFDR). A tsunami calamity is likely to strike practically every area of Indonesia.

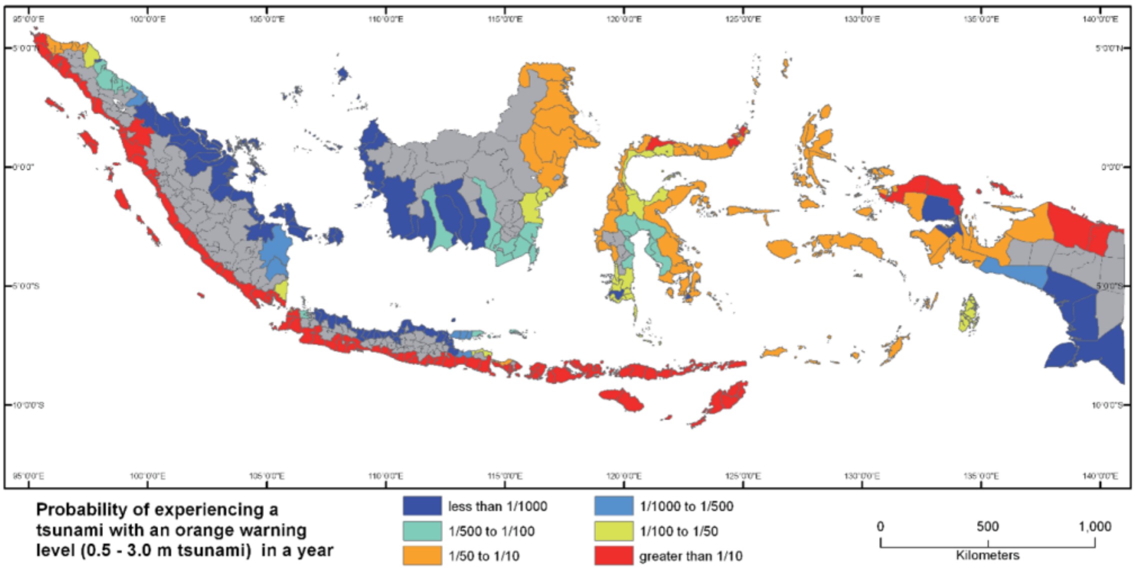


Figure 1. Tsunami Hazard in Indonesia by AIFDR (Source: Horspool et al., 2013)

In the context of the unique needs of the disabilities, efforts to recover, rehabilitate, and reconstruct are carried out in such a way as to anticipate and prepare residents to be more alert and alert to the occurrence of the tsunami (Fathiah et al., 2019; Goto et al., 2021). As one of the disaster mitigation efforts, the National Disaster Management Agency (NDMA), together with the Indonesian Deaf Welfare Movement (IDWFM), held a National Congress of Indonesian Sign Language in Disaster Management. However, Law Number 24 of 2007 concerning Disaster Management states that disability groups are protected groups in disaster events (as objects). However, they can also become actors (subjects) in Disaster Management through the capacity building of these groups. Efforts to pay attention to those with special needs are covered in the Head Regulation of the National Disaster Management Agency Number 14 of 2014 concerning Handling, Protection, and Participation of Persons with Disabilities in Disaster Management.

The advancement of technology is projected to result in the creation of efficient tsunami detection early warning systems to aid individuals, especially those disabilities-friendly, in raising their consciousness and preparing for the worst-case disaster scenarios before they occur. In line with this, the preparedness of families with disabilities children in the face of disasters; it was seen that the preparedness plan category was not ready (37.8%), the knowledge category was ready (42.2%), the resource mobilization category was not ready (82.2%), the tsunami disaster preparedness index value is 57% (ready category), the disaster warning category was not ready (46.7%) (Riviwanto et al., 2021). Governments in local areas must give persons with disabilities preferential attention (Fuady et al., 2021; Riviwanto et al., 2021). This study will summarize the development of a tsunami early warning system (TEWS) for disability groups so that from this study can be concluded the advantages, limitations, and updates that can be applied as an effort to realize the goals of the National Congress by NDMA so that parties to develop an inclusive early warning system, especially paying attention to the disabilities community. This congress is an important milestone because the disabled community, who have sign language, are willing to come together to agree on how they can contribute to disaster relief with their wealth of sign language (Schniedewind et al., 2020).

2. METHODS

This qualitative descriptive study uses data-gathering procedures based on the library research method. The first library research is collected. Then, the article was reduced to the most relevant topic of TEWS for disabilities group. This research produces descriptive analysis in a series of written sentences. According to Sugiyono (2017), the stages of analysis for qualitative research are generally depicted in Figure 2.

Qualitative data analysis includes four stages (Suliyanah et al., 2021), namely (1) Data collection is obtaining data from various trusted sources to obtain the required information that supports the ability of research objectives; (2) Data reduction is sorting out important things focused on the needs of the author to facilitate obtaining the desired data in line with the research objectives (Shafi et al., 2020; Sovacool et al., 2018); (3) Presentation of data is the exposure of research data which is generally in the form of short descriptions, charts, relationships between subjects, and so on for qualitative research types (Bauer & Scheim, 2019); (4) Conclusion and verification are the final results obtained after conducting a series of previous processes to attract new findings for the study's purpose.

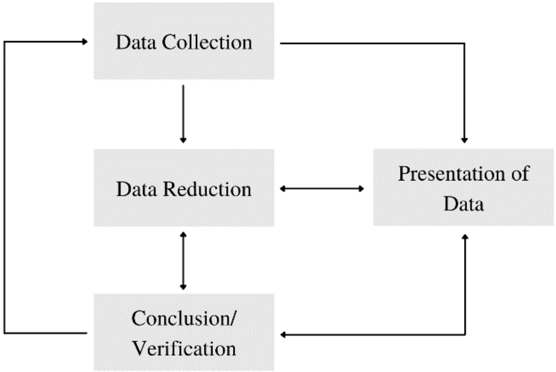


Figure 2. Stages of Qualitative Data Analysis in General (Sugiyono, 2017)

3. RESULTS AND DISCUSSION

3A. TEWS Based on IoT and Underwater Sensors

Tsunami mitigation is often accomplished by placing buoys along the shore, although this detection method has limits. Determining the sea level compared to specific guidance, whereas altimetry observation needs to be done continuously and correctly, usually carries out tsunami pulse observation on the shore. Furthermore, traditional markers are more extensive and more costly to use. Underwater Wireless Sensor Networks, in broad terms, may be utilized to collect and preserve information about broad geographical areas and transfer it to a headquarters for information processing and EW creation (Ding et al., 2021; Gola & Gupta, 2020; Jin et al., 2019). UWSNs are employed in a variety of programs, and the Internet of Underwater Things (IoT) is a framework that enables the identification and forecasting of occurrences that may lead to emergencies (Bhattacharya et al., 2022, 2022; Kotis et al., 2023; Mohsan et al., 2022), see in Figure 3.

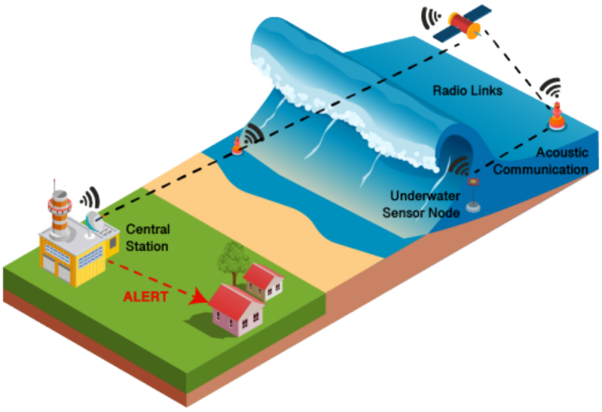


Figure 3. Integrating of TEWS based on IoT and Underwater Sensor (Source: Esposito et al., 2022)

In the context of Early Warning (EW), IoT solutions may be highly successful in data gathering, transmission, and disaster forecasting while being affordable. As a result, Wireless Sensor Networks, Cloud solutions, Machine Learning, and other Internet of Things components should be employed while implementing or integrating existing Early Warning Systems (EWS) (Esposito et al., 2022). Further research studies the uses of blockchain-enabled IoT, such as in Figure 4.

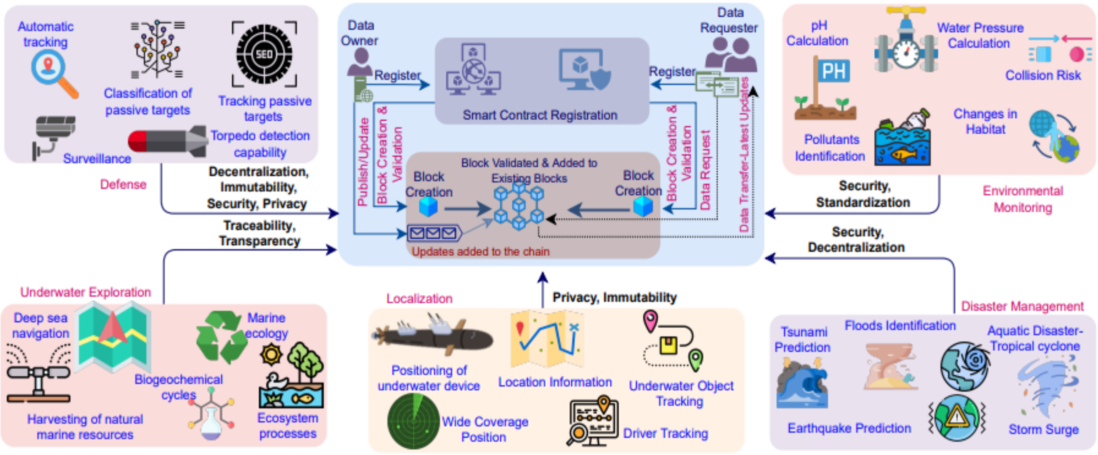


Figure 4. Blockchain-enabled IoT (Source: Bhattacharya et al., 2022)

IoT enables us to save numerous lives through emergency preparedness. As a result, the IoT allows for the connectivity of many devices; the IoT-empowered disaster preparedness system is utilized for EWS by applying data analysis and computational capabilities (Sharma et al., 2021). Although undersea investigation contributes significantly to nations' economies, research into the implementation of rising technologies like blockchain for the IoT is still in the early stages. Furthermore, due to their compact size and low construction and upkeep costs, IoT-based Inertial Measurement Unit (IMU) devices can be utilized as TEWS sensors (Suryanto et al., 2020). However, Anping Port in Taiwan found that low-cost IMUs had a good capacity for measuring the height of waves with both frequency and amplitude as relatively precise parameters (Huang et al., 2016).

3B. Inexpensive Device for Sea Level

IDSL research by Novianto et al. (2021) information concerning elevation is highly correlated with the BIG forecast information. The typical frequency of present-day information gaps is three to five minutes long, primarily due to transmission or transmission network interruption (Yunarto & Sari, 2018). IDSL is also equipped with CCTV to visually recognize the water lines as an indicator of a tsunami, as in Figure 6. However, previous research developed a Pacific TWS (PTWS) based on sea level Gauges (Pararas-Carayannis, 2015) as in Figure 5. PTWS provide an evaluation of both tsunami or earthquake in the Pacific Ocean Basin (Toulkeridis et al., 2022).

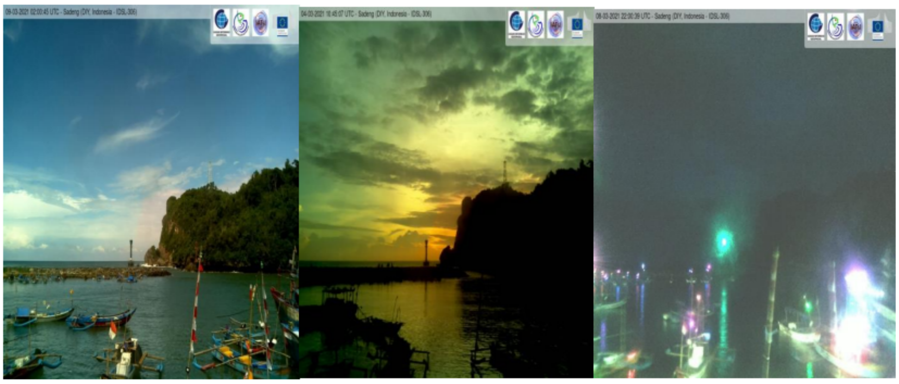


Figure 5. IDSL CCTV Image Comparison (Source: Novianto et al., 2021)

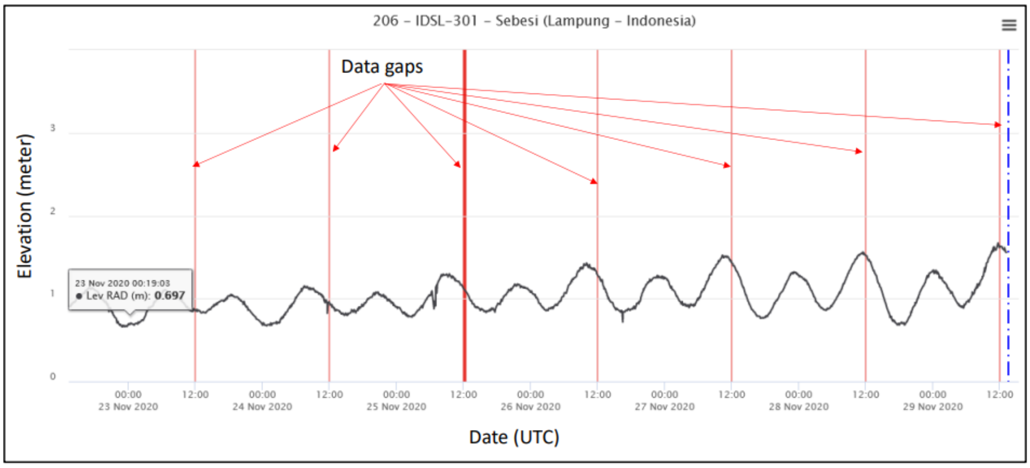


Figure 6. The Data Gaps During Rest Time of IDSL (Source: Husrin et al., 2022)

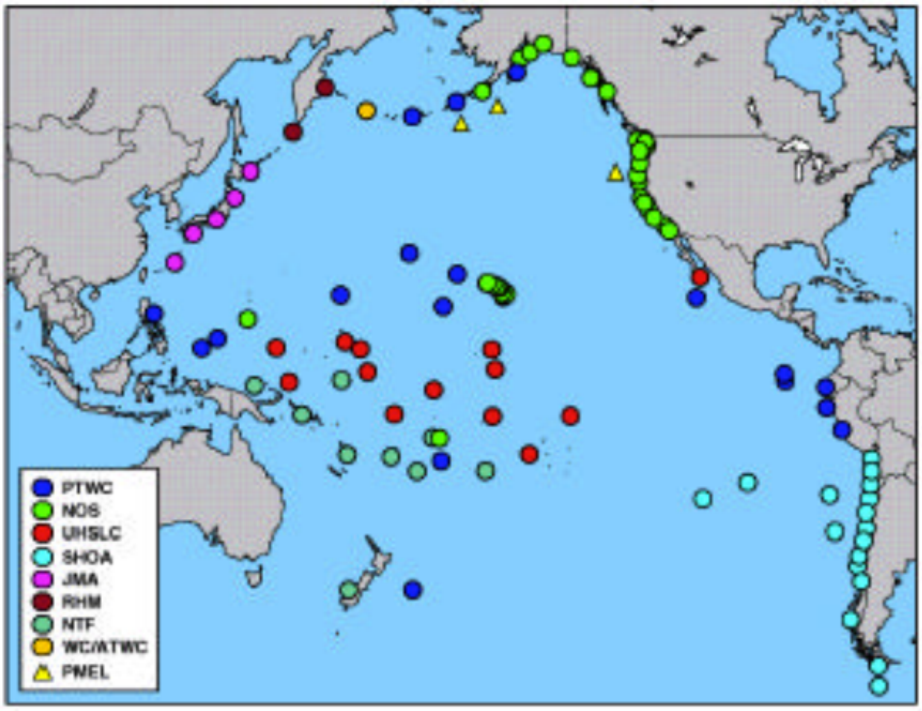
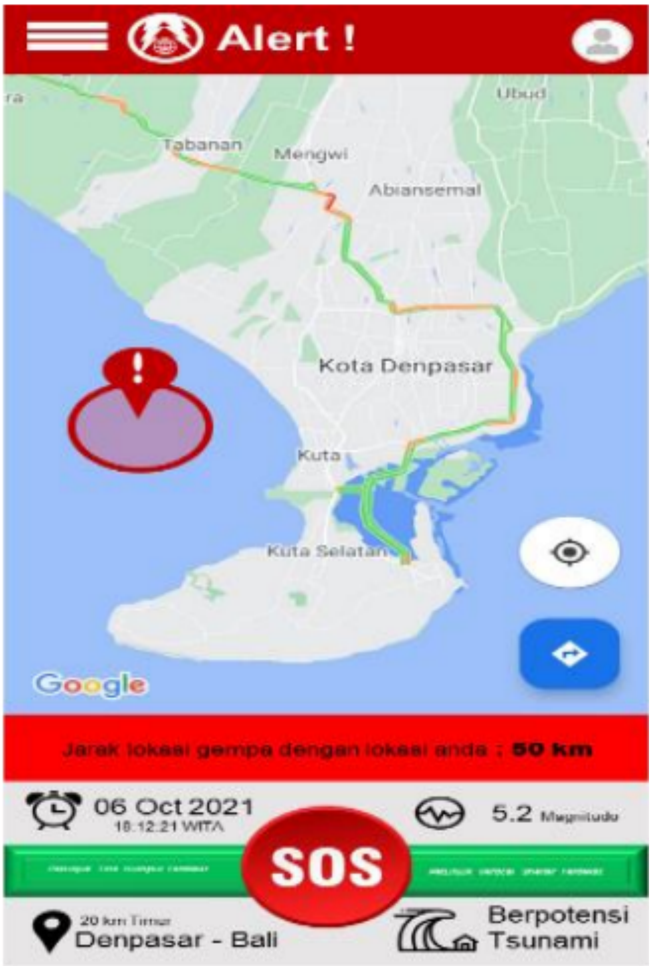


Figure 7. TWS Sea Level Gauges (Source: Pararas-Carayannis, **2015**)

Inconsistencies are missing data caused by a long delay time, a weak transmission system, or a communication breakdown. During the measurement process, poor connectivity and connection loss were caused by the operational handling of the equipment and the level of quality connectivity (internet) facilities. The only factor that may affect IDSL performance is the high delay time that occurs on occasion (Husrin et al., 2022). This mainly happened between 30 seconds and 5 minutes. Considering operational management, the amount of data breaches for IDSL was less than 9% (Husrin et al., 2021). The IDSL alert system is adequate for providing EW of wave abnormalities. However, it gets frequently disrupted by local occurrences, including vibrations from ships corroborated by CCTV photos in Figure 6 and 7. However, the development of IDSL is on high reliability as TEWS.

3C. Mobile-Based TEWS

Digitalization of technology with the help of mobile-phone applications has become very dominant in connectivity between people in various parts of the world. The digital world has become "critical" to today's society, but perhaps more should be addressed to realize its democratizing possibilities (Brody et al., 2018; Hantrais et al., 2021). Mobile-phone application at pace and scale, its general application in some sectors prompted legal, social, and security problems, along with increasing threats for underprivileged groups (Budd et al., 2020; Gallouj et al., 2015; Marabelli et al., 2021; Mumtaz et al., 2021). Several developments of TEWS are integrating mobile-based due to its practice of public awareness. Rais et al. (2022) developed android-based TEWS, such as in Figure 8.



Jarak lokasi gempa dengan lokasi anda : **50 km**

Figure 8. Android-based TEWS (Source: Rais et al., 2022)

The Android-based received a response time of fewer than five seconds to start receiving with retrieving the tsunami and earthquake data from the Meteorology Climatology and Geophysics Council webpage to trigger an early warning in users' Android-based. Furthermore, engineers upgrade the technology to distribute tsunami and earthquake information and provide evacuation direction guidance and survivor detecting functions to reduce catastrophe risk (Chamola et al., 2021; Lindell et al., 2021). However, due to the high volume of user activity, this function may have the opportunity to be interrupted.

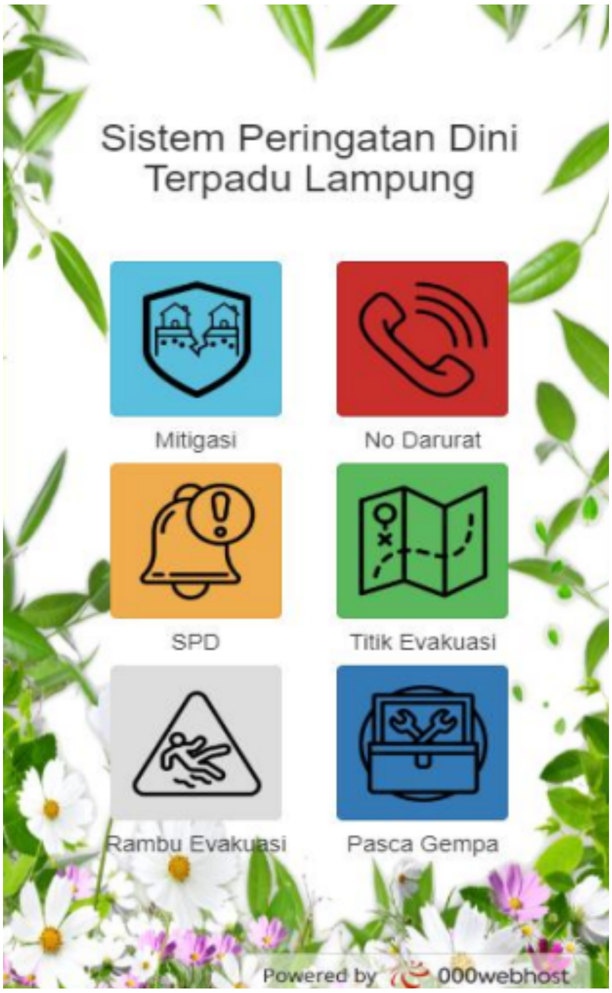
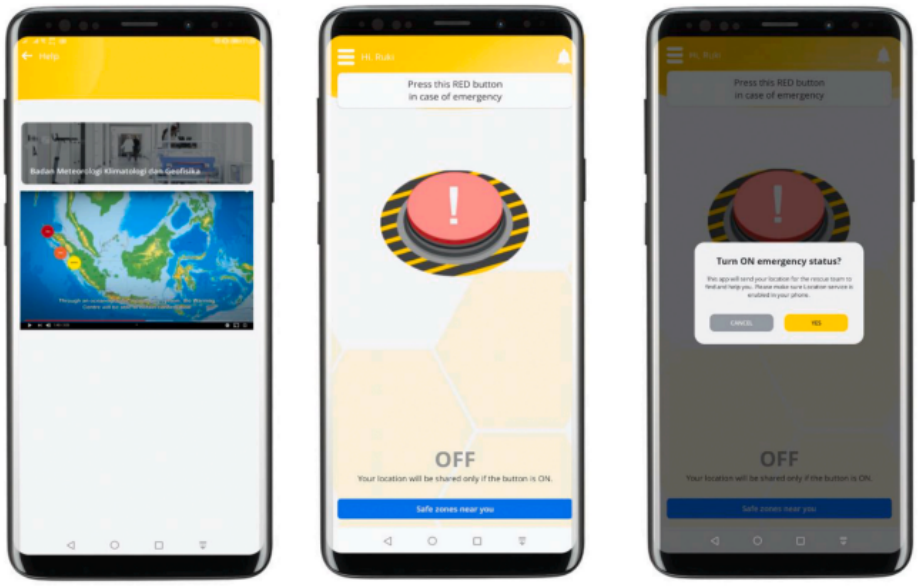


Figure 9. Integrated EWS of Lampung (Source: Imamura et al., 2019)

Furthermore, Imamura et al. (2019) developed a mobile-based named "Integrated EWS of Lampung" in Figure 9. This application consists of six menus: 1) mitigation, 2) emergency number, 3) EWS, 4) evacuation point, 5) evacuation signs, and 6) post-earthquake. This application is effective in giving alerts and knowledge as EWS. As a promising EWS, the "Integrated EWS of Lampung" can be developed for national purposes, such as in Figure 9. In line with this, the research by Berawi et al. (2021) developing *'SaveMyLife'* as a mobile-based help rescue in order to victims prioritized (Infants, elderly people, pregnant women, and other defined groups have relied extensively on physical facilities such as buildings, mode of transport, and ecological systems to ensure their life by providing shelter, nourishment, potable water, as well as access to energy), and technology utilized. Figure 10 is the development of *'SaveMyLife.'*



Press this RED button in case of emergency

Your location will be shared only if the button is ON.

Turn ON emergency status?

Figure 10. ‘*SaveMyLife*’ interface (Source: Berawi et al., 2021)

Various TEWS algorithms exist to provide educated tsunami source characterization for quick, limited notification. The mechanism by which this critical information is disseminated is an ignored part of TEWS (Davidson, 2022; de Silva, 2021). Current procedures are primarily focused on when an alarm is sent from a warning center; however, that notice goes through many groups and departments before reaching concerned populations (Williamson & Allen, 2023). However, there is a lack of attention from parties with authority in providing EWS, especially regarding warning of danger and emergency disasters that can reach the Deaf. Deaf people are almost entirely unable to recognize the distress warning signals issued by the Voice-Based Early Warning System (VBEWS).

The equipment for the EWS recommended by the study of Munandar et al. (2019) to complement the VB-EWS is Visual-Based Early Warning System Equipment (VisEWS) and Shock Vibration-Based Early Warning System Equipment (VibEWS). VisEWS is applied by using a hazard light placed where the Deaf can easily see it. Whereas VibEWS is applied by using devices such as smart bracelets or smart watches, or intelligent rings worn by deaf people when they are individually in public facilities, such as in hospital inpatient rooms or hotel rooms. Otherwise, the EWS offers professional sign-language translators in all catastrophe knowledge as required by the National Regulation on the fundamental rights of individuals who have disabilities as part of the disclosure of information for deaf citizens (Fauziyah & Jannah, 2022; Hansson et al., 2020).

4. CONCLUSIONS

The numerous TEWS has been developed as an effort to recover, rehabilitate, and reconstruct and are carried out in such a way as to anticipate and prepare residents to be more alert and alert to the occurrence of tsunami. IoT based on IMU devices can be utilized as TEWS sensors with minimum limitation. IDSL information concerning elevation is highly correlated with the BIG forecast information. The Android-based received a response time of fewer than five seconds to start receiving with retrieving the tsunami and earthquake data from the Meteorology Climatology and Geophysics Council webpage to trigger an early warning in users' Android-based. However, there is a lack of attention from parties with authority in providing EWS, especially regarding warning of danger and emergency disasters that can reach the Deaf. In conclusion, the EWS needs to be developed along with professional sign-language translators in all catastrophe knowledge as required by the National Regulation on the fundamental rights of individuals who have disabilities as part of the disclosure of information for deaf citizens. Hence, recommendations for further research are needed to develop the TEWS integrated with VBEWS, ViBEWS, ViSEWS, and sign language.

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