Power System Technology
ISSN:1000-3673

Received: 16-01-2024 Revised: 12-02-2024 Accepted: 07-03-2024

Design and Development of an Earthquake Database Application System for Monitoring and Analysis at the Bandung Class I Geophysical Station

Awan Setiawan

Informatics Engineering, Universitas Langlangbuana
Jl. Karapitan No.116, Cikawao, Kec. Lengkong, Kota Bandung
awans2425@gmail.com

Abstrak— The Province of West Java and its surrounding is the potential region for earthquake events because the south area of West Java is the point of junction of the plate tectonics Eurasia and Indo-Australia and added by the local fault of West Java region which is known as Balibis Fault. The web information system is very needed by the people who live in the south area of West Java and the potential earthquake event region.
The implementation of this system gives information about earthquake parameters and seismicity maps in the West Java region and its surroundings. The analysis uses the reading of earthquake parameters at Bandung Geophysics Station and is processed by using WGSN (World Global Seismographic Network) plot software.
This system shows a piece of integrated information, between earthquake parameter analysis results with earthquake seismicity map display in West Java.

Key Word: Earthquake Database, Application System, Seismic Monitoring System, Bandung Class I Geophysical Station

I. INTRODUCTION

Earthquake, or commonly known as a seismic tremor, is a natural phenomenon that occurs due to the shaking of the Earth's surface (Irwansyah et al., 2012). The main causes of earthquakes involve the interaction between tectonic plates in the Earth's crust. When these plates collide, friction and the accumulation of energy occur in the subduction zone, especially when the denser oceanic plate meets the continental plate (Puspitajati et al., 2013). At a certain point, the elastic limit of the plates can be exceeded, causing the rupture of rocks. When this rupture occurs, the accumulated energy is suddenly released, causing particle vibrations that propagate in all directions. This process creates seismic waves that can be felt on the Earth's surface (Astri et al., 2020).

Earthquakes have the potential for significant damage and can cause serious harm to the structures of buildings, infrastructure, and the surrounding environment (Mustofa et al., 2015).

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 Revised: 12-02-2024 Accepted: 07-03-2024
In addition to the collision of tectonic plates, volcanic activity and rock avalanches can also be causes of earthquakes. This event illustrates the complex dynamics of nature and reminds us of the immense power contained within the layers of the Earth (Widyarta et al., 2020). Therefore, understanding the sources and mechanisms of earthquakes is crucial for developing disaster risk mitigation strategies, as well as enhancing preparedness and resilience of communities in facing the unpredictable threat of earthquakes (Murtianto, 2016).
Since the early 20th century, Indonesia has witnessed several significant earthquake events that have shaken the region. Three notable seismic events in Indonesia's earthquake history include the Banda earthquake in 1983, the Sumatra earthquake in 2004, and the Nias earthquake in 2005 (Noor, 2014). The Banda earthquake in 1983 had an intensity reaching 8.5 on the Richter scale, while the Sumatra earthquake in 2004 recorded an intensity of 9.0 on the Richter scale, followed by a devastating tsunami. Additionally, the Nias earthquake in 2005 had an intensity of approximately 8.7 on the Richter scale (Lira, 2017).
The high intensity of these earthquakes is closely related to Indonesia's geographical position at the convergence of three major tectonic plates (Hamilton, 1979). Geographically, Indonesia is situated between the Indo-Australian plate to the south, which subducts relatively northward beneath the Eurasian plate, and the Pacific plate to the northeast (Richards et al., 2007). This position creates a dynamic and complex geological condition where the interaction between these plates can lead to collisions, friction, and the accumulation of energy, ultimately triggering earthquakes (Subarya et al., 2006).
Earthquakes, as a response to the movement of tectonic plates, often result not only in physical infrastructure damage but also in tragic loss of lives. One of the deadliest events in Indonesia's history occurred in December 2004 when an earthquake and tsunami struck Aceh and North Sumatra. During this event, the number of casualties reached an immense scale, with 110,229 people reported dead, 12,123 missing, and around 703,518 individuals forced to evacuate (du Lao, 2005)

The tremendous humanitarian impact of the 2004 Sumatra earthquake and tsunami posed significant challenges for the government and society in recovery efforts. In addition to addressing the loss of lives, rescue operations, and the search for missing persons, the government had to grapple with the severe damage to infrastructure (Meisl et al., 2006). This event became a catalyst for improving disaster preparedness, swift response, and mitigation planning at the national level, as well as enhancing international cooperation to face similar threats in the future. Since then, Indonesia has continued its efforts to establish early warning systems and enhance capacity to reduce the risks and impacts of earthquake and tsunami disasters (Sufri et al., 2020.
On the other hand, Indonesia has experienced rapid progress in the development of information technology, bringing significant transformation across various sectors. Without recognizing spatial and temporal boundaries, the advancement in information technology plays a crucial

Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

role in modernizing the operations of organizations and institutions throughout the country (Spahn et al., 2014). Many organizations utilize information technology to enhance efficiency and effectiveness in data and information management (Al mansoori et al., 2020).

The utilization of information technology, including information systems, plays a key role in supporting the rapid processing of data into information. This speed is particularly crucial in the context of managing earthquake events (Li et al. 2017). With information technology, earthquake data can be accessed, analyzed, and disseminated more efficiently, enabling faster decision-making. The implementation of technology and information systems not only assists organizations in managing the impacts of disasters but also improves preparedness and response to emergency events (Gasmelseid, 2014).

In the context of earthquake data and information, information technology provides invaluable support in the collection, analysis, and dissemination of information across all layers of society (Gunawan, 1999). With sophisticated information systems in place, experts and authorities can monitor earthquakes in real-time, provide early warnings, and design more effective disaster mitigation strategies (Agtrisari & Charter, 2004).

BMKG (Meteorology Climatology and Geophysics Council) has committed to enhancing preparedness and response to earthquakes in Indonesia. One concrete step that has been taken is the development of an earthquake database system. This system aims to provide better support in the operational and analytical aspects of earthquakes (Soedarmo, 1978).

With the existence of the earthquake database system, BMKG can collect, store, and manage earthquake data in a structured manner. This not only enables BMKG to have complete and accurate records related to earthquake events but also facilitates quick access to this information (Suhartono, 2014). Experts and researchers can use the data within this system to conduct further analyses regarding earthquake patterns, potential risks, and geophysical trends in the Indonesian region (Pribadi et al., 2021).

Furthermore, the development of the earthquake database system also supports early warning efforts. With rich historical data, BMKG can improve the accuracy of predicting potential earthquakes in the future and provide faster warnings to the public. This proactive step aims to reduce the adverse impacts that may arise from earthquakes (Kristanto, 2004).

Meteorological and geophysical observations in Indonesia began in 1841, initiated by Dr. Onnen, Head of the Hospital in Bogor. Initially, these activities were individual, but over time, the increasing need for weather and geophysical data prompted the formalization of these activities. In 1866, the Dutch East Indies Government recognized this activity as a government agency under the name Magnetisch en Meteorologisch Observatorium, led by Dr. Bergsma. The weather observation network continued to grow, reaching 74 stations in Java in 1879 (Konen et al., 1998).

This development involved moving observations of the Earth's magnetic field to Bogor in 1902, followed by earthquake observations beginning in 1908 in Jakarta. During the Japanese occupation (1942-1945), this agency changed its name to Kisho Kauso Kusho. After the

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 Revised: 12-02-2024 Accepted: 07-03-2024

proclamation of independence in 1945, this agency was divided into the Bureau of Meteorology in Yogyakarta and the BMKG (Meteorology, Climatology and Geophysics Agency) in Jakarta. BMKG, as a Non-Departmental Government Institution, has several stations throughout Indonesia, including the Bandung Class 1 Geophysical Station on Jl. Fir No. 66 Bandung. Despite adopting promising computerization technology, existing systems are not yet fully integrated. Therefore, an Earthquake Information System was designed for the Bandung Class 1 Geophysical Station, aiming to increase efficiency, transparency and integration in managing earthquake information (Safatrick, 2016).

West Java Province, with its location prone to earthquakes, is the focus of development. The existence of local faults such as the Cimandiri fault and the subduction zone where the Eurasian and Indo-Australian plates meet makes the risk of earthquakes in West Java quite high. Therefore, an earthquake database system is needed to support earthquake operations and analysis at the Bandung Class 1 Geophysical Station.

Earthquake risk analysis, including creating seismicity maps, is an important aspect of determining vulnerable areas. However, calculations and analysis carried out manually are not optimal. Therefore, an earthquake database system was designed, which is expected to speed up the calculation and analysis of earthquake parameters and seismicity maps. The resulting information is expected to be more communicative and can be easily accessed by the general public and policymakers, enabling more effective natural disaster mitigation.

II. LITERATURE REVIEWS

A. *Definitions of Earthquake*

An earthquake is a series of vibrations or shock waves that originate somewhere in the mantle or crust of the earth (Rikitake, 1968). American seismologists have developed a theory that explains generally how earthquakes occur, known as Elastic Rebound Theory. According to this theory, earthquakes occur in areas experiencing deformation, where the energy stored in the deformation takes the form of elastic strain. This energy will accumulate until the rock's bearing capacity reaches its maximum limit, which then causes cracks or fractures (Ohnaka, 1976).

Earthquakes are vibrations that occur on the earth due to the movement of tectonic plates. Earthquakes can occur on the earth's surface or inside the earth. When an earthquake occurs, the movement of tectonic plates can cause faults or cracks in the ground, which can result in landslides or damage to building structures (Bolt, 2001). Earthquakes can also cause tsunamis if they occur at sea. According to experts, earthquakes are vibrations that occur in the earth due to the movement of tectonic plates. Earthquakes can occur on the surface of the earth or inside the earth and can cause damage to building structures and other natural disasters (Lomitz, 2013). Apart from that, experts also state that earthquakes can occur suddenly and can have different

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*
intensities, depending on factors such as the depth of the earthquake source, the type and condition of tectonic plates, and geological conditions in the affected area (Stein & Wysession, 2009).

The mechanism of an earthquake can be explained as follows: if two forces are acting in opposite directions on the rock of the earth's crust, the rock will be deformed due to its elastic properties. If this force acts for a long time, the rock's bearing capacity will reach its maximum limit, causing sudden shifts and fractures. As a result, the stored stress energy is released in the form of vibrations known as earthquakes.

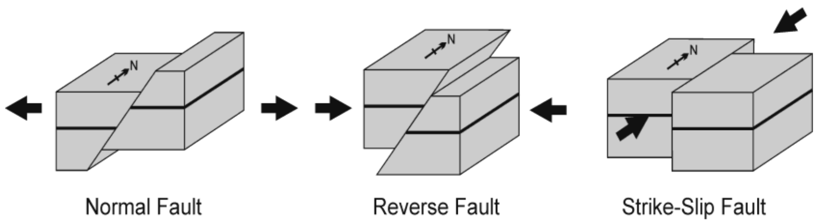


Figure 1. The process of plates meeting

B. Tectonic Conditions of West Java

The growth of geological structures in West Java is basically influenced by the collision activity between the Indo-Australian Plate which is subducting beneath the Eurasian Plate, (Hamilton, 1979). The impact of this plate collision created the main tectonic elements in the West Java region, including troughs, non-volcanic outer arcs, fore-arc basins, magmatism pathways, back-arc basins, and the Sunda Shelf, (Katili, 1973). Of the various fault structures formed in West Java, there are three regional structures that have an important role, namely the Cimandiri Fault, the Baribis Fault, and the Lembang Fault. The existence of these three faults was first identified by van Bemmelen in 1949, and it is believed that all three are still active today. Although all of these faults have a crucial role in the tectonic history of West Java.

The tectonic conditions of West Java, especially the southern part, are part of the Indonesian tectonic system and are located in the zone where tectonic plates meet. This area is prone to earthquakes because of the meeting of the Indo-Australian plate which has slipped under the Eurasian plate under West Java Island (Haryanto et al., 2020). The phenomenon of continental arc collision is thought to be controlling the fault deformation mechanism on the West Java mainland. This local fault is quite active in generating tectonic earthquakes in the area.

Power System Technology
ISSN:1000-3673

Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

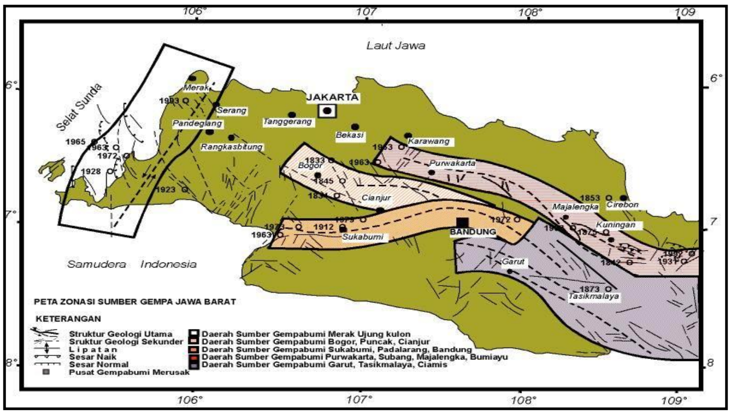


Figure 2. The main causes of earthquakes in West Java

C. *Earthquake Intensity*

Earthquake intensity is a measure of damage caused by an earthquake based on observations of its effects on humans, building structures and the environment (Gutenberg & Richter, 1942). The intensity does not only depend on the strength of the earthquake (magnitude) but also on the distance to the earthquake source and local geological conditions. There are several intensity measurement scales, such as the Modified Mercalli Intensity (MMI) scale and the European Macro seismic Scale (EMS) (Musson et al., 2010).

To provide information more easily, BMKG uses the GIS scale (Earthquake Intensity Scale). This scale states the impact caused by an earthquake. The Earthquake Intensity Scale (SIG-BMKG) was initiated and compiled to accommodate information on the impact of earthquakes based on typical culture or buildings in Indonesia. This scale is structured more simply by only having five levels, namely IV.SIG-BMKG which is expected to be useful for use in conveying information related to earthquake mitigation and/or rapid response to damaging earthquake events. This scale can make it easier for the public to understand the level of impact caused by an earthquake better and more accurately (Crisnapati et al., 2018).

D. *Management Information System (MIS)*

Management information systems are used in managing earthquake data to support decision-making. DBMS (Database Management System) is a key component in managing this data, enabling efficient storage, sorting and retrieval of data (Chopra, 2010). Earthquake intensity scales, such as the MMI scale, are used to describe the level of damage caused by an earthquake. An Earthquake Information Management System (EIMS) is a system that records, collects, stores, retrieves and analyzes input, generates necessary earthquake reports and information (EI) and presents them to the appropriate people and organizations to manage earthquake response activities (EI is not an end goal, but helps better decision making in policy design,

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 Revised: 12-02-2024 Accepted: 07-03-2024

response planning, disaster management, monitoring and evaluation of disaster programs and services, and damage reduction (Ajami, 2012).

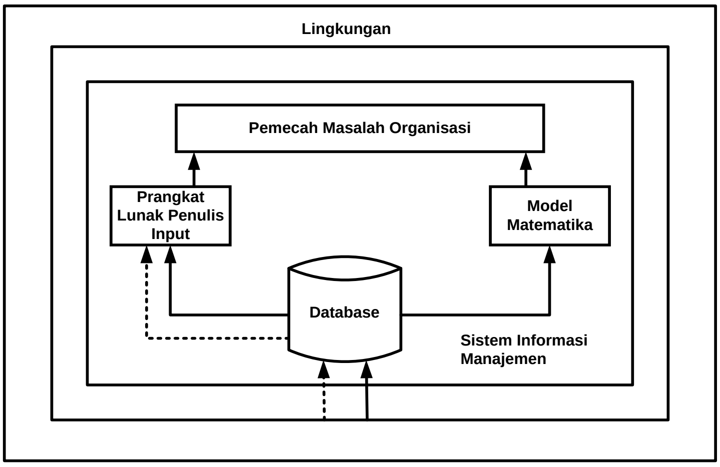


Figure 3. Management Information System Model

E. *Database Management System (DBMS)*

The concept of a database management system (DBMS) includes hardware, operating system, database, users, and other applications. The main goal of a DBMS is to provide information quickly, accurately and efficiently (Olle, 2003). A database is defined as a data warehouse that stores various kinds of data, organized in such a way as to facilitate data management and retrieval. In a database, tables are used to store data, with records as collections of similar data and columns as attributes that store similar data (Frank, 1988).

A DBMS provides a centralized view of data that can be accessed by multiple users from various locations in a controlled manner. A DBMS can limit what data end users see and how they see the data, providing multiple views of a single database schema. End users and software programs are free from having to understand where the data physically resides or on what type of storage media it resides because the DBMS handles all requests (Dayal, 1988).

A DBMS can offer logical and physical data independence to protect users and applications from having to know where data is stored or from worrying about changes to the data's physical structure. As long as the program uses the application programming interface (API) for the database that the DBMS provides, the developer does not need to modify the program simply because changes have been made to the database.

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

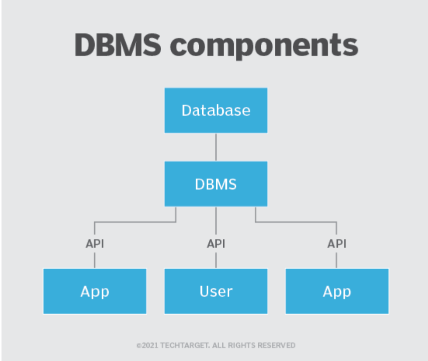


Figure 4. Database Management System (DBMS) Model

III. Research Method

A. Engineering Research Methodology

This research methodology encompasses Planning, Design, Construction, Application, and Development. The stages of the engineering method are as follows:

1. **Planning (Planning):** This phase involves an initial assessment using the process of evaluation and problem identification. Through the analysis of issues, specifications for needs and decision-supporting information are obtained for effective problem-solving.
2. **Analysis:** Involves decomposing a comprehensive information system into its components to identify and evaluate the required conflict issues. Consequently, proposals for improvements can be suggested.
3. **Design:** This phase involves the discovery or creation of a method, formula, model, or prototype tailored to the needs of potential users requiring solutions to specific problems. The design outcomes must be tested either mathematically/statistically or empirically.
4. **Construction:** This stage involves the realization of a product or system based on the previously tested design.
5. **Application (Implementation):** This is an effort involving diffusion, installation, adaptation/conversion, operation/actions, monitoring, control, maintenance, and evaluation of something previously discovered relevant to the needs of problem-solving.

Engineering research methods can take the form of forward engineering and reverse engineering. The following are explanations of each method:

1. **Forward Engineering:** This engineering proceeds from planning, design, and construction to application or through shorter engineering stages, such as from design to construction alone. The process starts from higher-level abstractions and progresses to lower levels.
2. **Reverse Engineering:** This involves engineering from existing products, systems, or prototypes to blueprints, formulas, or examples. It can focus on shorter engineering stages, from construction to design alone. The process starts from lower-level abstractions and progresses to higher levels.

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

The research method employed in this study utilizes engineering methodology with a forward engineering approach. The research stages are outlined in Figure 5 as follows:

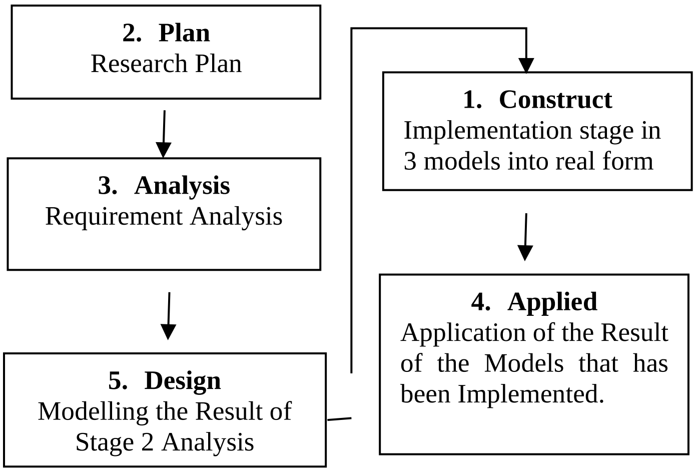


Figure 5: Forward Engineering Research Method

1. **Plan:** The initial planning stage of the research process, defining goals and the scope of development, identifying existing problems, and determining solutions through system development.
2. **Analysis:** Decomposing a comprehensive information system into its components to identify and evaluate expected problems, facilitating proposed solutions.
3. **Design:** This stage involves modelling the results of the analysis, an advanced step in system development after analyzing the system.
4. **Construct** The implementation stage of a model formed in stage 3, turning it into a tangible form.
5. **Applied:** The application stage of the implemented software model to the user.

B. Model Waterfall

The waterfall model or what is often called the waterfall model is often called the classic life cycle, it describes a systematic and sequential approach to software development, starting with user requirements specifications and then continuing through the planning stages, modelling, construction and delivery of the system to customers/users (deployment), which ends with support for the complete software produced.

In its development, the waterfall model has several sequential stages, namely: requirements (needs analysis), system design (system design), coding (coding) and testing (testing). (Rizaldi, 2017).

The stages in the Waterfall model can be seen in Figure 6 below:

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

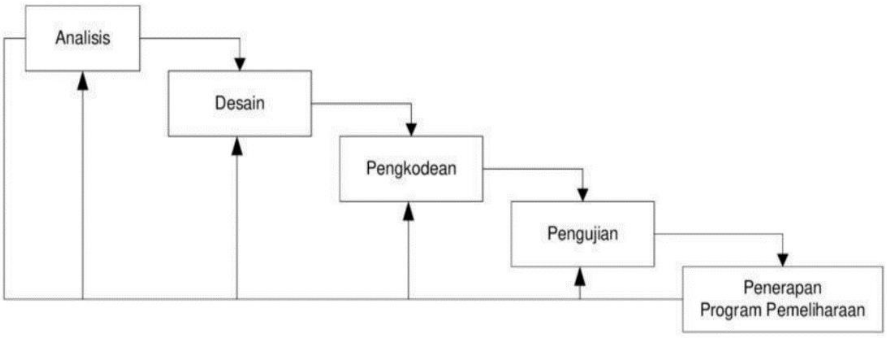


Figure. 6 Model Waterfall

1. Analysis, at this stage system developers need communication aimed at understanding the software required by users and the limitations of that software. This information can generally be obtained through interviews, discussions or exclusive surveys. information is analyzed to receive the data expected by the user.
2. Design, and requirement specifications from the previous stage will be studied in this phase and a system design will be prepared. System Design helps in determining hardware and system requirements and helps in defining the overall system architecture.
3. Coding, in this stage, the system is first developed in small programs called units, which are integrated in the next stage. Each unit is developed and tested for functionality which is called unit testing.
4. Testing, all units developed at the implementation stage are integrated into the system after testing carried out by each unit. After integration, the entire system is tested to check for any failures and errors.
5. Implementation of a maintenance program, the final stage in the waterfall model. Software that has been completed, run and maintained. Maintenance includes correcting errors not found in the previous steps. improving the implementation of system units and improving system services as new requirements.

IV. RESULT AND DISCUSSION

A. *Usecase Diagram*

The system/application model being developed is depicted in the following use case diagram:

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

Figure 7 Use case Diagram

The earthquake information management system involves the participation of four distinct actors: the head of BMKG, application users (operators), administrators, and the general public. Each actor plays a specific role in utilizing the system to manage and disseminate earthquake-related information effectively. The use case scenarios for administrators and the general public share similarities, albeit with a key distinction.

For administrators, such as those overseeing the BMKG system, their role extends to monitoring all users of the application who are affected by the earthquake. This elevated access allows administrators to have a comprehensive view of the system's activities and user interactions during seismic events. This capability empowers them to coordinate and respond more efficiently to the dynamic situation presented by earthquakes.

On the other hand, the use case for the general public, while similar in functionality to the administrator, is limited to accessing information about their relatives. This tailored access ensures that individuals directly impacted by the earthquake can receive pertinent information about the safety and well-being of their loved ones.

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 Revised: 12-02-2024 Accepted: 07-03-2024

In Figure 6, the use cases for these four actors are likely represented diagrammatically, illustrating the various interactions and functionalities tailored to the unique roles of each actor within the earthquake information management system. These visual representations aid in understanding how the system accommodates the needs and responsibilities of different users in times of seismic events.

B. *Class Diagram*

A class diagram or class diagram is a type of structure diagram in UML that clearly depicts the structure and description of the classes, attributes, methods and relationships of each object. It is static, in the sense that the class diagram does not explain what happens if the classes are related, but rather explains what relationships occur. This class diagram is suitable if implemented in projects that use object-oriented concepts because the description of the class diagram is quite easy to use. The class diagram required in developing the Earthquake Database Application system is as follows:

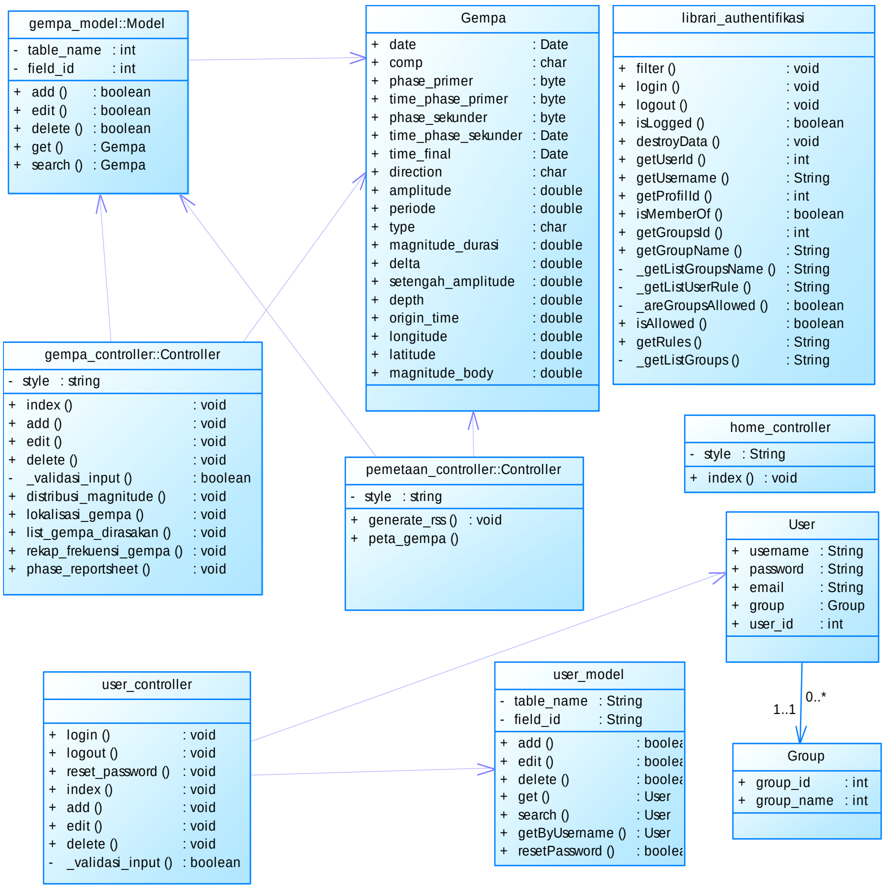


Figure 8 Class Diagram Earthquake Database Application

Power System Technology
ISSN:1000-3673

Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

The class diagram above illustrates the roles of user. In this application, users can receive notifications from the app, report incidents in their area, and request assistance. Afterward, user plays a role in providing valuable real-time information, databases, and alerts sent to admins. User can then process and post this information on the application. The class diagram provides a clear overview of the tasks and interconnections between users, controller and admins in the context of this application. Users play a crucial role in obtaining up-to-date information about earthquakes. They can receive notifications from the app regarding earthquake events, report incidents in their area, and request assistance if needed. The active involvement of users is an integral part of data collection and a rapid response to emergency situations.

As an institution with expertise in meteorology, climatology, and geophysics, BMKG plays a central role in providing highly useful up-to-date information. This includes updates from their database and direct notifications to administrators regarding earthquake events. With this role, BMKG directly contributes to the processing and delivery of accurate information to users. Admins,as application administrators, play a crucial role in managing and disseminating information. They receive alerts from BMKG, process them, and then post them on the application for users to access. This task requires a quick response and effective coordination to deliver relevant and reliable information to application users.

.

C. Implementation System

The implementation results of the Earthquake monitoring system interface design are shown in Figures 9 - 15 below:

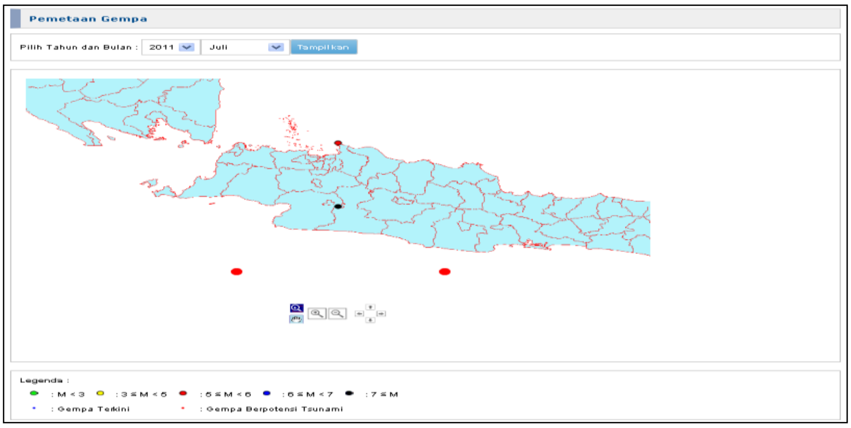


Figure 9 Public Display of Earthquake Mapping

In Figure 9, the public display of earthquake mapping for West Java is evident, complete with a legend explaining the earthquake intensity scale, recent earthquakes, and earthquakes with

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 Revised: 12-02-2024 Accepted: 07-03-2024

potential tsunamis. This comprehensive display provides users with essential information regarding seismic activity in the region. The inclusion of a legend facilitates a quick understanding of the earthquake intensity scale, enabling users to promptly comprehend the severity of the earthquakes. Additionally, clear information about recent earthquakes and those with tsunami potential is presented. Consequently, users can easily identify the location, intensity, and characteristics of earthquakes, providing valuable insights for preparedness and emergency response. The presence of this legend is a key aspect in facilitating the interpretation of earthquake data on the mapping, making it an effective tool for understanding and addressing earthquake risks in West Java.

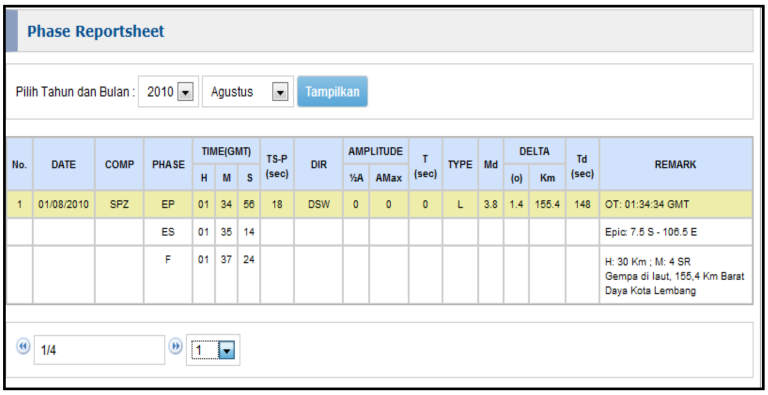


Figure 10 Public Display of Phase Report sheet

On the earthquake public display of phase report sheet in figure 10, users have access to comprehensive information about the specific earthquake event, encompassing precise details such as the exact time of occurrence, including hours, minutes, and seconds. Additionally, the intensity scale of the earthquake is prominently displayed, offering users a clear understanding of the severity of the seismic activity. This detailed information provides users with a nuanced perspective on the temporal and intensity aspects of the earthquake, enabling them to make informed assessments and decisions related to their safety and response strategies. The accessibility of such detailed data enhances the user's ability to grasp the specifics of the earthquake event, contributing to a more informed and prepared community in the face of seismic occurrences.

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

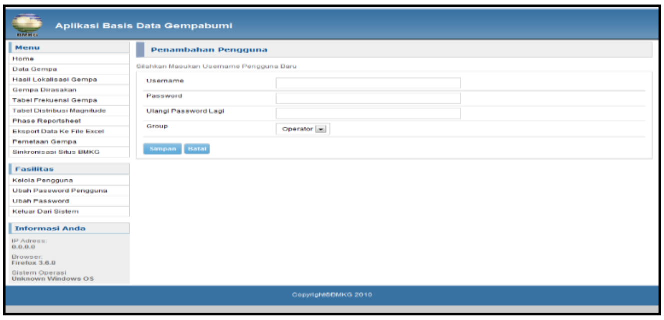


Figure 11 User Addition View

In Figure 11, the user addition view interface is showcased, which serves the purpose of adding new users or operators to utilize this earthquake database application. Typically operated by administrators, this feature allows for the seamless inclusion of new users who will contribute to the effective functioning of the application. The user addition view provides administrators with a user-friendly platform to manage and expand the user base, ensuring that the application remains accessible to a diverse group of individuals involved in earthquake-related activities. This administrative capability not only streamlines the onboarding process for new users but also contributes to the overall efficiency and inclusivity of the earthquake database application.

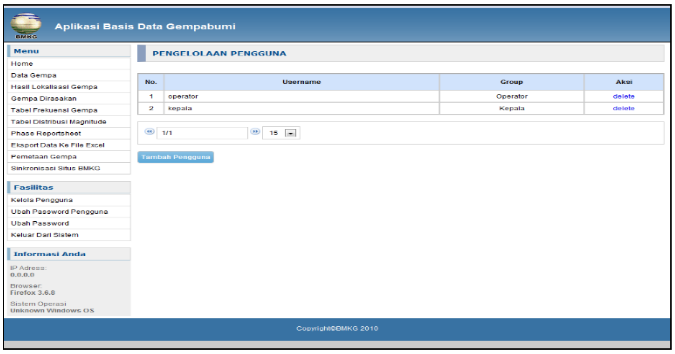


Figure 12 User Management

Figure 12 illustrates the user management interface in the earthquake database application. This page provides functionality to add and remove operators as well as the head of BMKG, serving as supervisors and verifiers. The user management feature offers flexibility to administrators for easily managing the user team, allowing adjustments to the user structure based on operational needs. The ability to add or remove operators and the head of BMKG also supports more effective data supervision and verification. With this interface, administrators can efficiently oversee the user team, ensuring security and orderly usage of the earthquake database application.

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

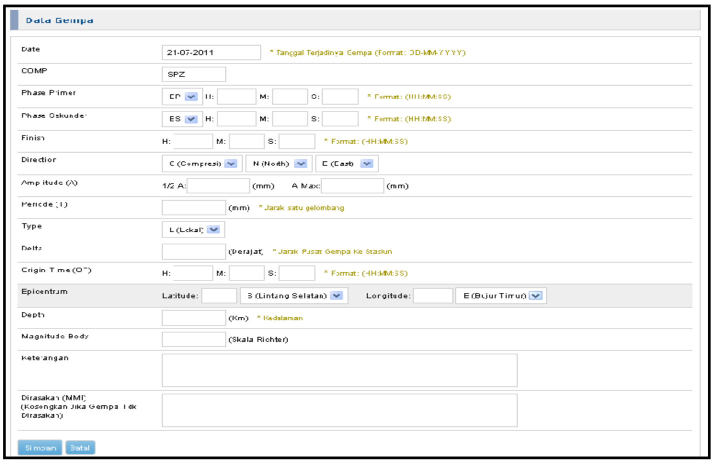
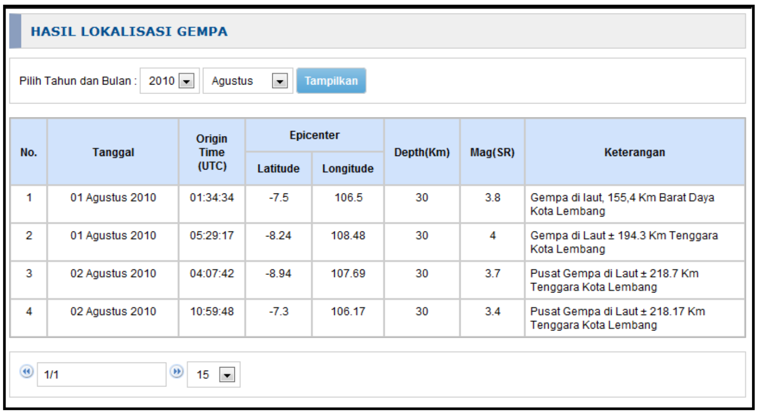


Figure 13 Entry Data Earthquake

Figure 13 illustrates the data entry form for earthquakes, encompassing various crucial details of seismic events. This data entry interface allows users to input essential information, including the earthquake's location, intensity scale, amplitude, depth, and other relevant parameters. Users can systematically record key characteristics of earthquakes through this form, contributing to a comprehensive database that aids in the analysis and understanding of seismic activities. The inclusion of multiple data fields ensures a thorough and accurate documentation process, facilitating effective monitoring and assessment of earthquake events. This data entry form serves as a vital tool for users involved in managing earthquake-related information, fostering the collection of detailed and precise data for further research and decision-making.



HASIL LOKALISASI GEMPA

Pilih Tahun dan Bulan : 2010 Agustus Tampilkan

No.	Tanggal	Origin Time (UTC)	Epicenter		Depth(Km)	Mag(SR)	Keterangan
			Latitude	Longitude			
1	01 Agustus 2010	01:34:34	-7.5	106.5	30	3.8	Gempa di laut, 155,4 Km Barat Daya Kota Lembang
2	01 Agustus 2010	05:29:17	-8.24	108.48	30	4	Gempa di Laut ± 194.3 Km Tenggara Kota Lembang
3	02 Agustus 2010	04:07:42	-8.94	107.69	30	3.7	Pusat Gempa di Laut ± 218.7 Km Tenggara Kota Lembang
4	02 Agustus 2010	10:59:48	-7.3	106.17	30	3.4	Pusat Gempa di Laut ± 218.17 Km Tenggara Kota Lembang

1/1 15

Figure 14 Display of Earthquake Localization Results

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 Revised: 12-02-2024 Accepted: 07-03-2024

The results of earthquake data input in Figure 13 will be subsequently displayed through the "Display of Earthquake Localization Results," as seen in Figure 14. This display provides a clear visualization of the earthquake localization outcomes, showcasing the information previously entered. Users can quickly observe the earthquake's location, intensity scale, amplitude, depth, and other crucial parameters inputted through the data interface. With this informative display, users can gain a comprehensive overview of the earthquake's characteristics and understand its implications. The Display of Earthquake Localization Results interface serves as an effective tool for visualizing earthquake input data, facilitating better interpretation, and supporting further analysis related to seismic activity.

TABEL DISTRIBUSI MAGNITUDE GEMPABUMI

Pilih Tahun dan Bulan : 2010 Agustus Tampilkan

Tanggal	Hari	Distribusi Magnitude		Tidak Diketahui gel(S) dan (Md)	Jumlah
		1.0 < M < 4.0	M ≥ 4.0		
01 Agustus 2010	Minggu	2	0	0	2
02 Agustus 2010	Senin	2	0	0	2

1/1 15

Figure 14 Magnitude Distribution Display

Image 15 illustrates a table depicting the distribution of earthquake magnitudes, including information on dates, days, and the magnitude distribution of various seismic events. This table provides a chronological overview of earthquake magnitudes on specific dates and days. The distribution of magnitudes offers insights into the variation of earthquake strengths during a specific time period. By examining this table, users can easily analyze patterns in the distribution of earthquake magnitudes and identify events that may have larger impacts. The display of this magnitude distribution table serves as a useful tool in presenting structured data, facilitating a better understanding of the distribution of earthquake magnitudes..

V. Conclusion

Based on the research results described in the previous chapters, the following conclusions can be drawn:

Implementation of the Web-Based Earthquake Database Application System Design and Build System produces application programs to handle main processes such as:

Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

a. Calculation of Earthquake Energy and Strength.
   The Web-Based Earthquake Database Application Design System handles the process of calculating and analyzing the amount of energy released during an earthquake using the Guttenberg and Richter methods and Jeffrey Bullen's table approach.
b. Earthquake Database in West Java and surrounding areas.
   A database that is stored and can be accessed by the public is one of the goals that will be implemented in designing this application.
c. Integrated Earthquake Seismicity Map.
   Integrated map facilities are provided by the system, including maps of earthquake seismicity, magnitude, and earthquake epicentres. The map output can be used as a basis for considerations for analysts in the field as a basis for making decisions regarding earthquake patterns in West Java.

REFERENCES

1. Agtrisari, I., & Charter, D. (2004). Desain dan Aplikasi Geographics Information System. *Jakarta: PT Gramedia Jakarta*.
2. Ajami, S. (2012). A comparative study on the earthquake information management systems (EIMS) in India, Afghanistan and Iran. *Journal of Education and Health Promotion*, *1*.
3. Al Mansoori, S., Salloum, S. A., & Shaalan, K. (2020). The impact of artificial intelligence and information technologies on the efficiency of knowledge management at modern organizations: a systematic review. *Recent advances in intelligent systems and smart applications*, 163-182.
4. Astri, R., Mulya, D. P., & Mazni, D. I. (2020). Sistem Informasi Geografis Peringatan Dini Bencana Gempa Bumi Dan Tsunami Di Kota Padang. *Jurnal Sains dan Informatika: Research of Science and Informatic*, *6*(2), 92-97.
5. Bolt, B. A. (2001). The nature of earthquake ground motion. *The seismic design handbook*, 1-45.
6. Chopra, R. (2010). *Database Management System (DBMS) A Practical Approach*. S. Chand Publishing.
7. Crisnapati, P. N., Wulaning, P. D., Hendrawan, I. N. R., & Bandanagara, A. A. K. B. (2018, August). Earthquake damage intensity scaling system based on raspberry Pi and Arduino Uno. In *2018 6th International Conference on Cyber and IT Service Management (CITSM)* (pp. 1-4). IEEE.
8. Dayal, U. (1988, January). Active database management systems. In *Proceedings of the Third International Conference on Data and Knowledge Bases* (pp. 150-169). Morgan Kaufmann.

Received: 16-01-2024 Revised: 12-02-2024 Accepted: 07-03-2024

9. du Lao, E. (2005). Indonesia: preliminary damage and loss assessment-The December 26, 2004 natural disaster.
10. Frank, A. U. (1988). Requirements for a database management system for a GIS. *PHOTOGRAMM. ENG. REMOTE SENS.*, *54*(11), 1557-1564.
11. Gasmelseid, T. M. (2014). Improving emergency response systems through the use of intelligent information systems. *International Journal of Intelligent Information Technologies (IJIIT)*, *10*(2), 37-55.
12. Gunawan, T., et al. (1999). *Analisis Statistik Keaktifan Gempabumi di Indonesia tahun 1900-1998*, Bulletin Meteorologi dan Geofisika No.4.
13. Gutenberg, B., & Richter, C. F. (1942). Earthquake magnitude, intensity, energy, and acceleration. *Bulletin of the Seismological society of America*, *32*(3), 163-191.
14. Hamilton, W. B. (1979). *Tectonics of the Indonesian region* (Vol. 1078). US Government Printing Office.
15. Hamilton, W. B. (1979). *Tectonics of the Indonesian region* (Vol. 1078). US Government Printing Office.
16. Haryanto, I., Ilmi, N. N., Hutabarat, J., Adhiperdana, B. G., Fauzielly, L., Sendjaja, Y. A., & Sunardi, E. (2020). Tectonic and geological structures of gunung kromong, west java, Indonesia. *GEOMATE Journal*, *19*(74), 185-193.
17. Irwansyah, E., Saputra, T. B., Piu, L., & Wirangga, K. (2012). Pengembangan Aplikasi Sistem Informasi Geografis Untuk Monitoring Gempabumi. *Jurnal Informatika*, *11*(1), 49-54.
18. Katili, J. A. (1973). Geochronology of West Indonesia and its implication on plate tectonics. *Tectonophysics*, *19*(3), 195-212.
19. Können, G. P., Jones, P. D., Kaltofen, M. H., & Allan, R. J. (1998). Pre-1866 extensions of the Southern Oscillation Index using early Indonesian and Tahitian meteorological readings. *Journal of Climate*, *11*(9), 2325-2339.
20. Kristanto, A. (2004). Konsep Dan Perancangan *Database*. Jakarta: ANDI.
21. Li, T., Xie, N., Zeng, C., Zhou, W., Zheng, L., Jiang, Y., ... & Iyengar, S. S. (2017). Data-driven techniques in disaster information management. *ACM Computing Surveys (CSUR)*, *50*(1), 1-45.
22. Lira, N. (2017). Analisis Parameter Seismik Gempabumi Wilayah Lengan Timur Sulawesi dengan Metode Empiris. *Universitas Islam Negeri Alauddin, Fakultas Sains dan Teknologi, Makassar,(Skripsi)*.
23. Lomnitz, C. (2013). *Global tectonics and earthquake risk*. Elsevier.
24. Meisl, C. S., Safaie, S., Elwood, K. J., Gupta, R., & Kowsari, R. (2006). Housing reconstruction in northern Sumatra after the December 2004 great Sumatra earthquake and tsunami. *Earthquake Spectra*, *22*(3_suppl), 777-802.
25. Murtianto, H. (2016). Potensi kerusakan gempa bumi akibat pergerakan patahan sumatera di sumatera barat dan sekitarnya. *Jurnal Geografi Gea*, *10*(1), 80-86.

Power System Technology
ISSN:1000-3673
Received: 16-01-2024 Revised: 12-02-2024 Accepted: 07-03-2024
26. Musson, R. M., Grünthal, G., & Stucchi, M. (2010). The comparison of macroseismic intensity scales. *Journal of Seismology*, *14*, 413-428.
27. Mustofa, A., Rosidi, A., & Sofyan, A. F. (2015). Analisis Sistem Informasi Geografis untuk Bencana Gempa Bumi Terintegrasi di Daerah Istimewa Yogyakarta. *Data Manajemen dan Teknologi Informasi (DASI)*, *16*(2), 19.
28. Noor, D. (2014). *Pengantar Mitigasi Bencana Geologi*. Deepublish.
29. Ohnaka, M. (1976). A physical basis for earthquakes based on the elastic rebound model. *Bulletin of the Seismological Society of America*, *66*(2), 433-451.
30. Olle, T. W. (2003). Database management system (DBMS). In *Encyclopedia of Computer Science* (pp. 517-520).
31. Pribadi, K. S., Abduh, M., Wirahadikusumah, R. D., Hanifa, N. R., Irsyam, M., Kusumaningrum, P., & Puri, E. (2021). Learning from past earthquake disasters: The need for knowledge management system to enhance infrastructure resilience in Indonesia. *International Journal of Disaster Risk Reduction*, *64*, 102424.
32. Puspitajati, D. I., Djunaedi, A., & Kusumadewi, S. (2013). Pengembangan Model Sistem Informasi Manajemen Bencana Gempa Bumi Berbasis WEB. *SEMNASTEKNOMEDIA ONLINE*, *1*(1), 08-7.
33. Richards, S., Lister, G., & Kennett, B. (2007). A slab in depth: Three‐dimensional geometry and evolution of the Indo‐Australian plate. *Geochemistry, Geophysics, Geosystems*, *8*(12).
34. Rikitake, T. (1968). Earthquake prediction. *Earth-Science Reviews*, *4*, 245-282.
35. Safatrick, F. (2016). Laporan Praktek Kerja Lapangan Di Badan Meteorologi Klimatologi Geofisika (BMKG) Stasiun Geofisika Klas 1 Bandung.
36. Soedarmo, R. P. (1978). *Statistical Analysis of The Earthquake Occurence and Seismic Activity in Some of Indonesia Region*. Jakarta : Seminar Berkala Meteorologi dan Geofisika, BMG.
37. Spahn, H., Hoppe, M., Kodijat, A., Rafliana, I., Usdianto, B., & Vidiarina, H. D. (2014). Walking the last mile: contributions to the development of an end-to-end tsunami early warning system in Indonesia. In *Early Warning for Geological Disasters: Scientific Methods and Current Practice* (pp. 179-206). Berlin, Heidelberg: Springer Berlin Heidelberg.
38. Stein, S., & Wysession, M. (2009). *An introduction to seismology, earthquakes, and earth structure*. John Wiley & Sons.
39. Subarya, C., Chlieh, M., Prawirodirdjo, L., Avouac, J. P., Bock, Y., Sieh, K., ... & McCaffrey, R. (2006). Plate-boundary deformation associated with the great Sumatra–Andaman earthquake. *Nature*, *440*(7080), 46-51.
40. Sufri, S., Dwirahmadi, F., Phung, D., & Rutherford, S. (2020). Progress in the early warning system in Aceh province, Indonesia since the 2004 earthquake-tsunami. *Environmental Hazards*, *19*(5), 463-487.

Power System Technology
ISSN:1000-3673

Received: 16-01-2024 *Revised: 12-02-2024* *Accepted: 07-03-2024*

41. Suhartono, S. (2014). Data processing methods in multimedia home platform applications for earthquake early warning of potentially tsunami services based interactive digital television. *Journal of Theoretical and Applied Information Technology*, *70*(3), 488-495.
42. Widyarta, R. M., Setyonegoro, W., & Arifin, J. (2020). Sistem Informasi dan Analisa Gempabumi Menggunakan Jisview pada Studi Kasus Gempabumi Tasikmalaya. *JIKA (Jurnal Informatika)*, *4*(2), 88-96.