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The Designing of Geoinformation Backend-Frontend to Improve Landslide Mitigation Application

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ABSTRACT

The necessity of designing geoinformation backend-frontend is to improve landslide mitigation application built for landslide disaster management is discussed in this article. The design of geoinformation backend-frontend is critical to ensure that the landslide mitigation application will run appropriately. This research seeks to address the geoinformation backend-frontend with three subject which are input to the landslide mitigation map objective, determination of selected evacuation sites and landslide hazard mitigation services presented in the form of application. The development of landslide mitigation was done online using the waterfall model. Web-based applications are developed in programming languages as the backend. Web applications can run on the Internet or an intranet (LAN network) and can manage data centrally. The system architecture design was made based on the client-server model, where the client sends and requests JSON data from the web service located on the server with the support of using Leaflet JS API as the base map layer. The geoinformation will communicate with the database using JSON String to make changes and retrieve data in the database. The JSON String is obtained from the Web Services Application Programming Interface (API), which is available for data processing in the system database. The front end is presented as a website. This section is created using HTTP, CSS, and JavaScript so that the URL can work and be displayed on the website properly. Meanwhile Frontend developers have the task of developing all the visual components of the website and keeping the interface attractive. With a series of advantages and models built, some things could be improved in the design process, such as the choice of relevant data, analysis methods and service features that can be presented as a more interactive mobile application.

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1. Introduction

Geoinformation can collect data that exists in information generating centres, cross-correlate previously uncorrelated information, and provide consumer reference data, with the role of being part of the deployment of new technologies and valuable information. From Jardim *et al.,* [13] study, it allows developers and users to expand situational awareness and better manage more coordinated operations. Geoinformation has now become a tool used for information collection and identification of information automatically and is not bound by administrative boundaries. Rakhmonov *et al.,* [24] show that it is flexible and easy to manage. De Souza *et al.,* [7] involves geoinformation to the development of basic hardware that can be integrated and adapted to different sensing needs and applications, such as temperature, pressure, motion, rotation and vibration. Nugroho *et al.,* [21] implement geographic information systems (GIS) to allows users to search information lists of state-owned buildings and provide detailed information about buildings and building permit status.

Web-based platforms are an important instrument for mitigating non-structural landslide risks. As the technical capabilities of monitoring tools improve and their costs decrease, non-structural mitigation measures are expected to evolve. From an economic perspective, non-structural mitigation methods usually require lower costs than structural methods. However, a significant challenge in implementing these "soft" mitigation strategies is a lack of confidence in their effectiveness and durability. This obstacle can be overcome by improving the quality of monitoring sensors and combining them in an efficiently designed web platform that includes good data management, robust API integrations, and advanced analytics tools. In addition, web-based platforms should be used to interact with at-risk communities through specially designed websites.

The platform plays a dual role. First, it allows data accumulation through community participation by uploading photos of initial indications of landslides. Second, educate populations in risk zones about monitoring and mitigation, increasing their awareness and response to disasters. Bossi *et al.* [6] proof that by increased awareness and information is important in strengthening response and recovery when danger occurs. From Lehtonen *et al.,* [16] experience, visualizing and classifying this amount of information into a form-based web application is challenging, especially when the goal is to serve the end user.

2. Workplace Experiences

This is a representation tool for developing landslide mitigation via the web using a waterfall model. The Waterfall model is a system development model that takes the basic process activities of specification, development, validation, and evolution and represents them as separate process phases, such as requirements specification, software design, implementation, testing, etc. from Pressman experience cited by Fauzi [8]. Numeric techniques within GIS provide clear and traceable outcomes but differ in complexity and data requirements. However, experts must consider these methods more closely, and there's room for improvement in utilizing the latest data and tools to create regulation-based mapping documents. Thiery *et al.* [30] from his research studies indicate that these modern numerical methods, web services, and tools can enhance understanding and provide dependable alternatives compared to traditional expert approaches, even within regulatory contexts.

Web-based applications are developed in programming languages such as *HTML*, *PHP*, *CSS*, and *JS*. Execution requires a web server and Chrome, Firefox, Opera, and other browsers. They can also operate on the Internet or intranet (*LAN* network) and manage data centrally. The important role with the network which is cyber security is one of the priorities in this workplace when we implement Hafizul Fahri *et al.,* [34] model in this study to control the security of the data.

3. Workplace Dissonance

Numeric techniques within GIS provide clear and traceable outcomes but differ in complexity and data requirements. However, experts must consider these methods more closely, and there's room for improvement in utilizing the latest data and tools to create regulation-based mapping documents. Numerous research studies indicate that these modern numerical methods, web services, and tools can enhance understanding and provide dependable alternatives compared to traditional expert approaches, even within regulatory contexts as from Thiery *et al.,* [30].

4. Effects on Subsequent Intentions

The outline of all the available layers for users to access in the online environment for each tool, with GIS features directly accessible online. The online mapping interface is likely open to the public, including users interested in environmental justice but needing more GIS knowledge. In such cases, presenting data straightforwardly and simplified may be more beneficial. Conversely, advanced GIS functions like buffering and statistical analysis are valuable for transportation practitioners, academics, and local officials needing desktop GIS software access. Hence, Spriggs *et al.* [28] evaluate the functionality of the chosen GIS tool on a spectrum from simplicity to complexity, with simplicity enhancing usability for the public and complexity catering to transportation industry professionals.

The front end represents a website's visual interface, crafted with HTML, CSS, and JavaScript. It enables users to view and engage with the site. Mufti *et al.,* [19] *said, e*ach programming language employed for front-end development requires a framework to enhance the website's appeal and ensure visitors feel comfortable navigating its pages. A back-end web application developer's responsibilities involve creating a database table and adding fields with specified row counts. Hathwar and Ravishankar [11] found that a back end are accountable for server-side scripting and primarily concentrate on developing server-side logic, maintaining database, and optimal performance and responsiveness to front-end requests.

5. Theoretical Framework

The system architecture design outlined adopts the client-server model, where the client, namely the landslide mitigation geospatial application, exchanges JSON data with a web service situated on the server. The Leaflet JS API serves as the base map layer. The geospatial application interacts with the database through JSON Strings for data manipulation and retrieval. These JSON strings are retrieved from the Web Service's Application Programming Interface (API), facilitating data processing within the system's database. Additionally, employing the Spherical Law of Cosines formula, the geospatial landslide mitigation feature calculates the distance from the user, who has provided information on the potential disaster level and evacuation points. Subsequently, upon specifying the distance, the application visually depicts the route from the source to the destination location using the JS Leaflet as in Figure 1.

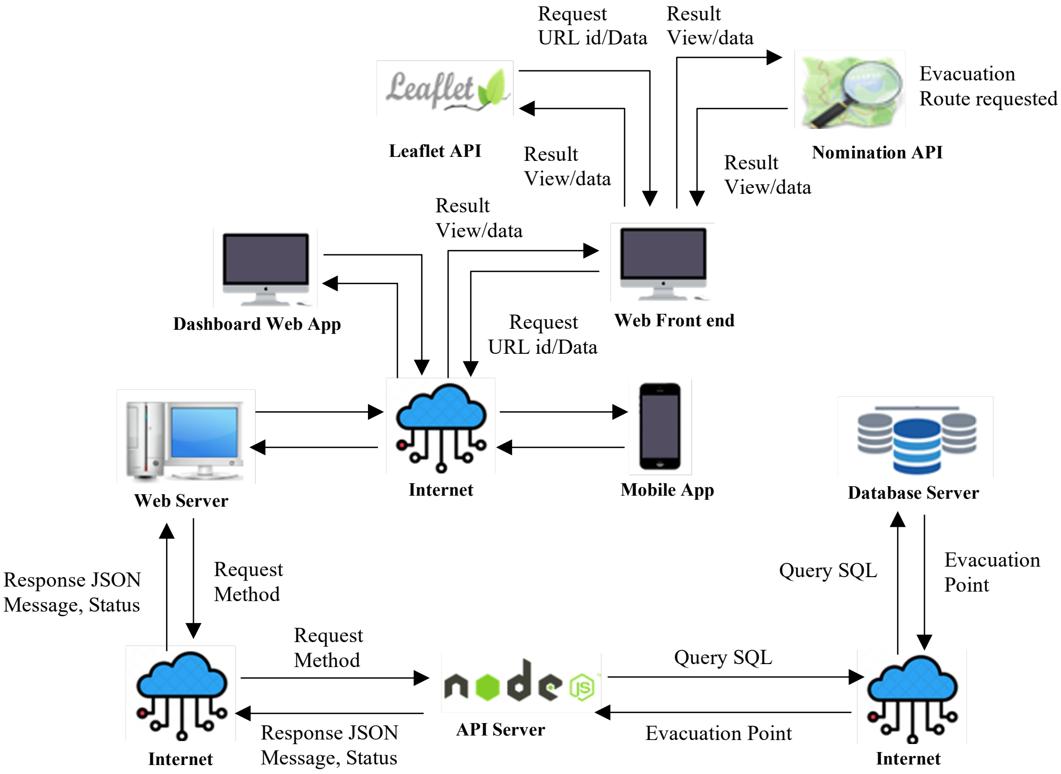


Fig. 1. System architecture design

API development and service integration encompass various skills focused on technical aspects related to core development. Michael Ayas *et al.,* [18] has informed that Full-stack development, closely linked to the former, comprises competencies that consolidate knowledge and expertise in full-stack web development. Architecture patterns provide solutions to software architecture challenges within software engineering. They are utilized to articulate the structural layout or blueprint for software systems. Vasconez *et al.,* [31] stated that these patterns offer a series of pre-established subsystems delineating their roles, regulations, and guidelines governing their organization, communication, interaction, and interconnections . Node.js is a programming language perfect for tasks that do not require heavy cryptographic calculations. It is very effective in providing quick responses to incoming requests. Rompis [26] claim that, PHP offers the most stable performance compared to different applications and provides a good balance between resource usage and response speed.

6. Methodology

6.1 UML (Unified Modelling Language)

In system development, utilizing UML models streamlines the design process to match user preferences better. According to Prihandoyo [22] Subsequent research aims to enhance information systems, aligning them more closely with present requirements and increasing adherence to user expectations. A use case diagram in Figure 2 depicts the functionality of the developed information system. It helps identify the system's functions and the users authorized to perform them as mentioned by Katarina *et al.,* [15].

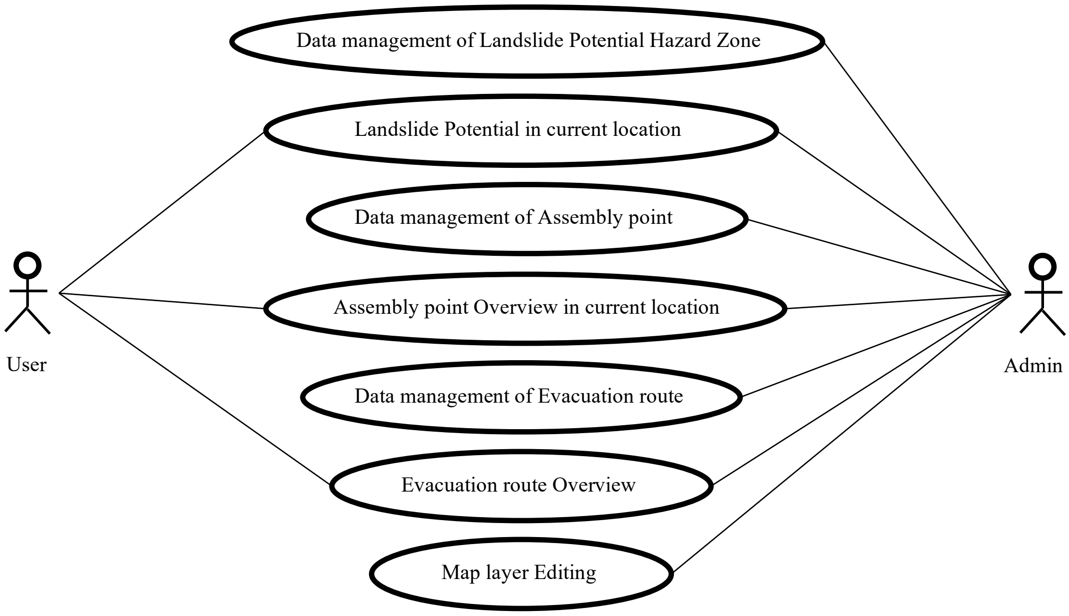


Fig. 2. Use case diagram

Affandi and Syahputra [2] said that activity diagram as shown in Figure 3 is a modelling tool used to represent the different processes within a created system. It illustrates the flow of control for the system's various actions.

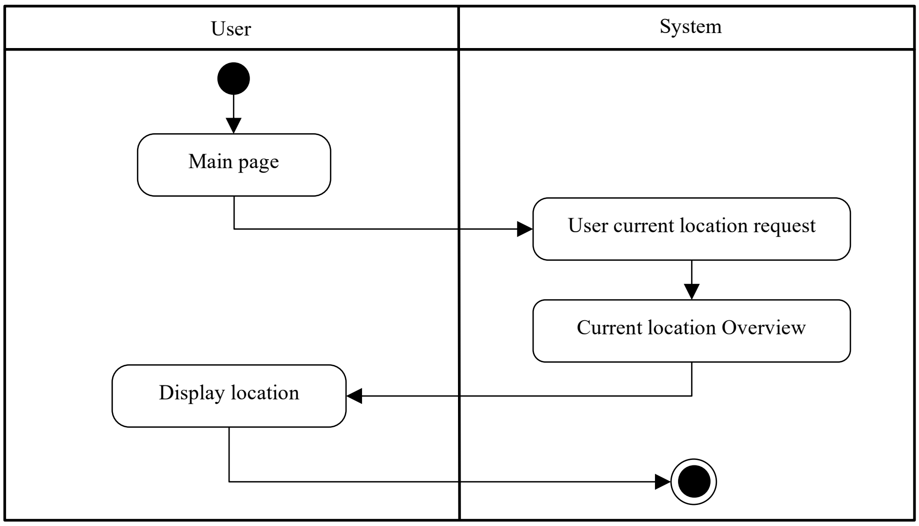


Fig. 3. Activity diagram of front end

According to Affandi and Syahputra [2] a sequence diagram portrays how objects behave within a specific use case, showing the messages exchanged between them. Creating a sequence diagram as in Figure 4 requires identifying the objects participating in the use case and their corresponding class methods.

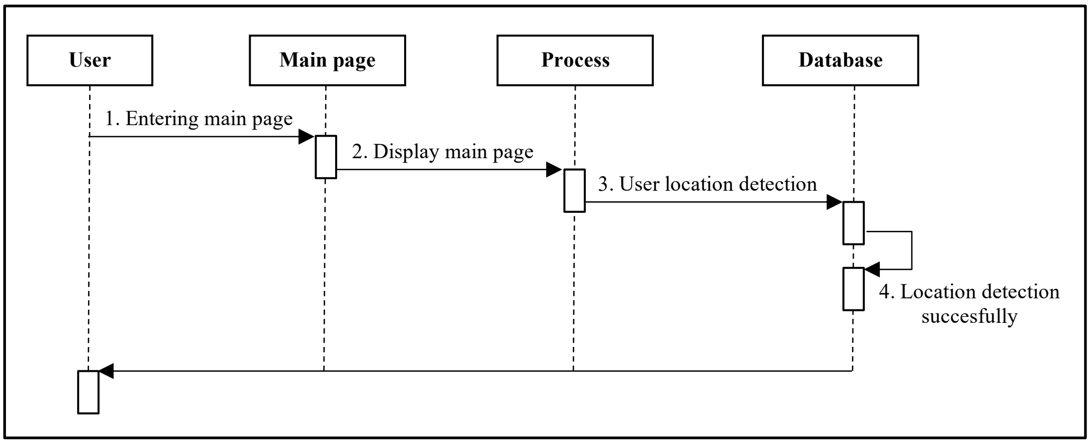


Fig. 4. Sequence diagram of front page

A class diagram in Figure 5 visually represents a system's fixed object architecture, displaying the classes of objects and their relationships with other classes. According to Affandi and Syahputra [2] Class diagram also can represent models for embedded systems, illustrating node configurations, client-server setups, fully distributed systems, and application reengineering. UML models can comprise various diagrams, each offering a distinct view of the system under development. To facilitate the development and progression of Xcrum, diverse UML diagrams were generated at different stages of the project. Machado *et al.,* [17] initial phase involves gathering fundamental requirements, leading to the creation of detailed requirements categorized as follows.

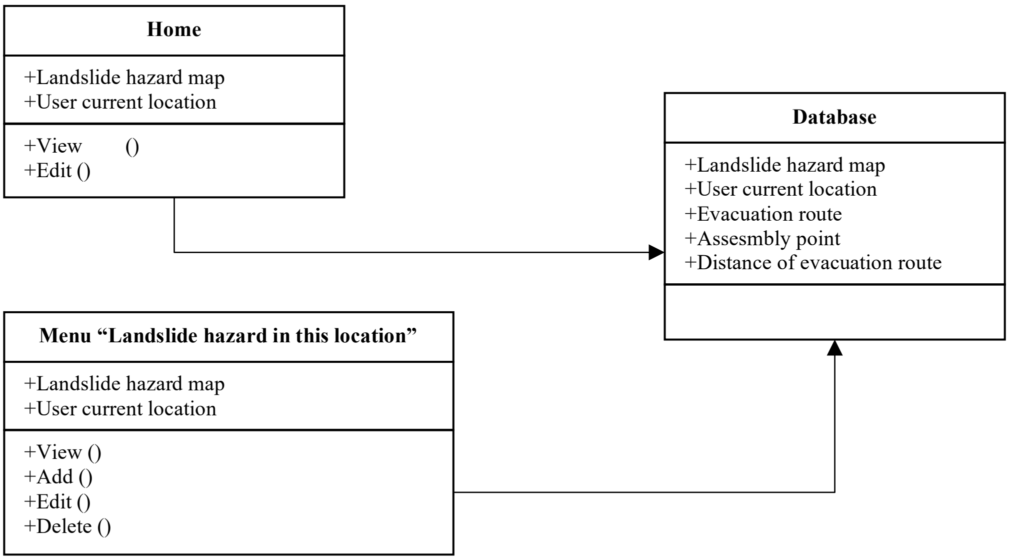


Fig. 5. Class diagram

6.2 Site Map

The site map of the mobile application consists of three important parts: the map panel, the mitigation panel and an interactive and attractive background map layer as presented in Figure 6. The design of the site map is kept simple to make it easy for users to interact with the application and provide information that focuses on the options without being distracted by the many features available.

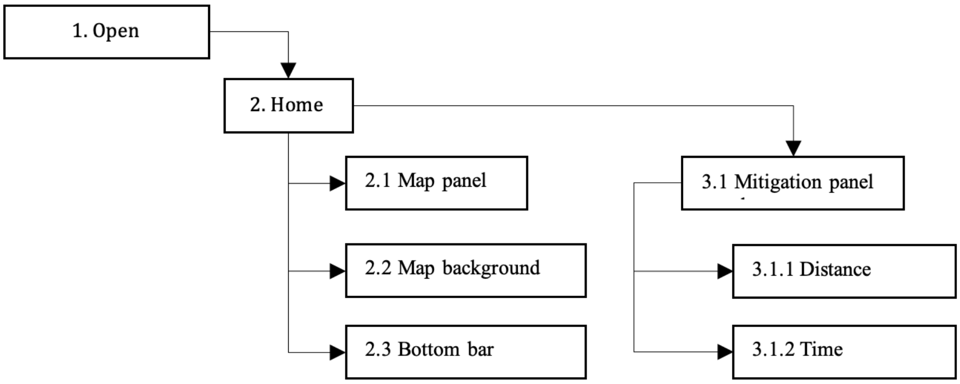


Fig. 6. Site map of mobile application

The user chooses the parameters and elements to be assessed for the report and specifies the type of report desired. Quirós *et al.,* [23] share that fundamental stack interacts with an analytical workflow, transmitting parameters via command lines and data in JSON file format. Cloud Server is the heart of the Web-GIS monitoring platform and supports data management from Gobakis [10] study. The Node.js application package ecosystem, commonly called Node Package Manager (npm), hosts the most extensive repository of open-source modules globally. It offers a multitude of modules and dependencies essential for web application development from Widodo [32] experience. CodeIgniter stands out among PHP frameworks for developing websites. Arinata & Anggara [3] said that this framework, characterized by its compact yet powerful nature, caters to developers seeking a straightforward and refined tool for crafting robust web applications.

7. Finding and Discussion

7.1 Web Application

A website comprises interconnected pages hosted on a domain accessible via the Internet, serving a particular purpose. The primary objective behind website creation is to streamline information exchange among researchers in their respective fields. Websites can be owned by individuals, organizations, or companies. They typically focus on a specific topic, although contemporary websites often cover a range of subjects as also mention by Arinata and Anggara [3]. Various options span from custom-built solutions deployed on dedicated servers, employing a comprehensive suite of open-source web mapping tools, to fully serviced products provided by commercial software providers as reported by Fournier [9]. The homepage serves as the visual interface for administrators, showcasing geospatial data about Potential Landslide Hazards, utility facility layers depicting evacuation points, and rescue routes utilizing the available road network features as example in Figure 7.

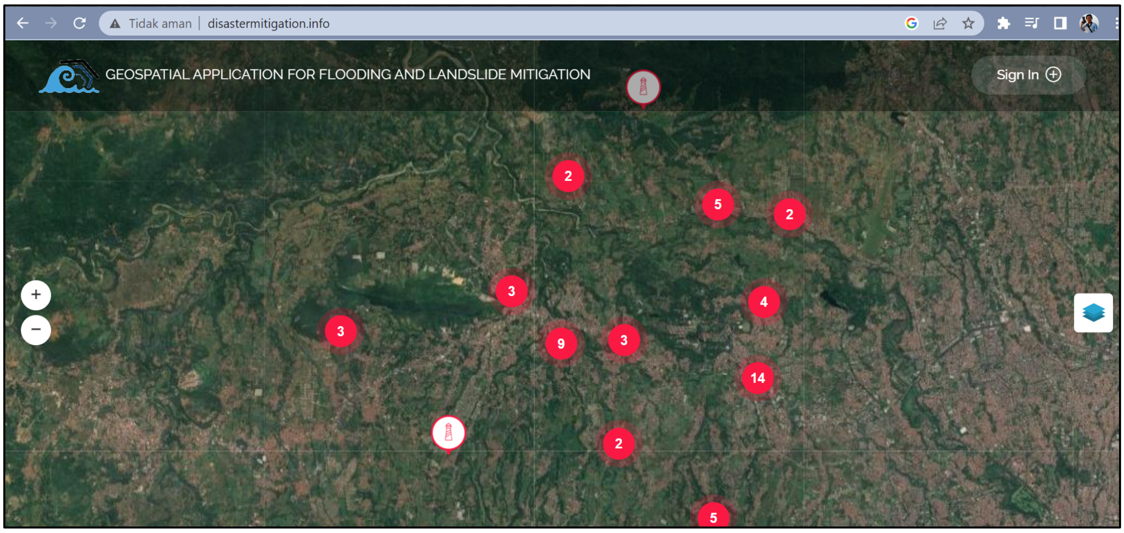


Fig. 7. Home page

Making expert knowledge more transparent and accessible is a challenging task for tool makers, and it also requires stakeholders to have the time and interest to learn the assumptions and programs used. Indeed, technologies like GIS come with history and genealogy that determine mapping paths, options for data display, and more. While researchers and experts can work to make their knowledge more accessible and indeed responsive, it is important to acknowledge the structures embedded in any knowledge system as consistently mentioned by Fournier [9].

The login page is the gateway for web administrators to reach the management page. It grants access to web administration privileges by prompting users to input authentication data as a username and password as shown in Figure 8.

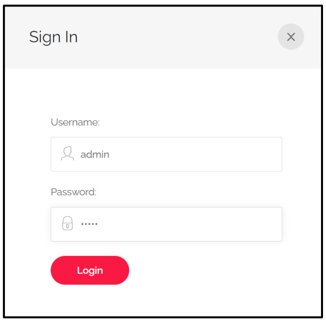


Fig. 8. Sign-in page

Once the user, acting as an administrator successfully navigates through the Login page, they can access the Administrator page as in Figure 9. This page grants comprehensive privileges to add (or replace) and delete geospatial information layers such as Potential Landslide Hazards, utility facilities, and road networks.

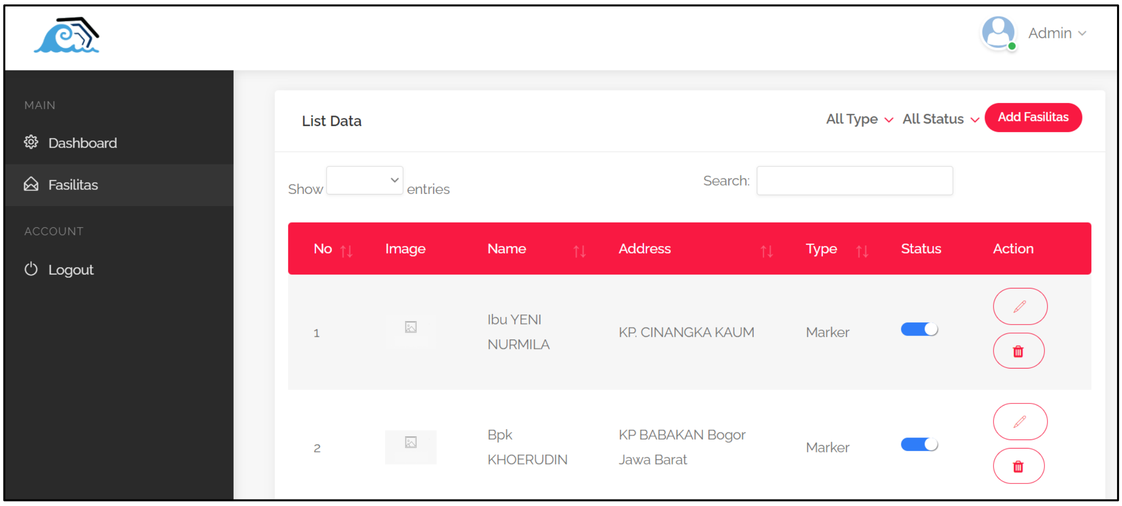


Fig. 9. Data maintenance page

At the second level of the system architecture, which is the interaction level, users must be able to interact with data maps at various levels visually. It requires the implementation of real-time tools such as zoom-in, zoom-out, and panels, among other things. This capability distinguishes geographic information software from statistical software, which only produces static maps. On the other hand, geographic information software continuously processes data on each user event to affect the changes in the display displayed to the use, according to Rodriguez *et al.,* [25].

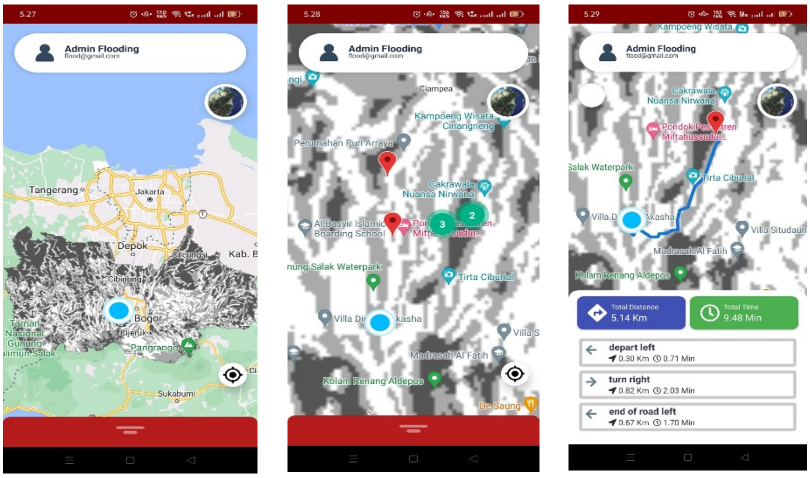
According to Szujó *et al.,* [29] web-based software proves useful when treating extracted materials to ensure high efficiency and productivity. WebGIS development goes beyond conventional databases, providing users with web-based visualization and analysis tools useful for planning, decision-making, and completing coordination tasks. Nourjou & Hashemipour [20] inform that the spatial web service provides tools for disaster management and response in real-time through assistance in prioritizing the recovery of operations in electric utilities to reduce the economic impact of blackouts. It can improve the efficiency of recovery operations in energy utilities, improve real-time decision-making and real-time planning, enable real-time monitoring, support operational decisions and problem solving. According to Wu *et al.,* [33] the Web-GIS allows users to analyse the system's temporal and spatial data characteristics through preset queries and self-customized conditions. In Avanidou *et al.,* [4] study, Web-GIS operates through a geodatabase that stores all data. This includes data on field location and geometry, data on practices for each field, including all inputs and outputs, and landscape element data.

The front end is the part of the website responsible for displaying the interface to the user. Arinata and Anggara [3] created this section using HTTP, CSS, and JavaScript so the URL could work and display the website well. Front-end developers, the people who work in this field, develop all the visual components of a website and keep the interface attractive. They are also responsible for designing the layout of the website or app's front screen or user interface to create a more engaging user experience.

7.2 Mobile Application

A mobile app view is a front-end sitemap visualization created on the Android platform and interrelated computer components that include the hardware, software, and users interacting with the computer system. An app is a collection of programs built and connected to perform specific tasks to assist humans in their work. Android is a Linux-based operating system for smartphones, tablets, and electrical gadgets such as smartwatches and other electronic devices according to Sifauttijani *et al.,* [27].

The mobile application's layout comprises three crucial components: the map section, the mitigation section, and the interactive and captivating background map layer. Its design remains straightforward, facilitating user interaction and delivering focused information without overwhelming them with numerous features. The mobile app sitemap consists of three important parts as shown in Figure 10. The map panel (b), the mitigation panel (c) , and the interactive and engaging background map layer. The sitemap design remains simple for users to interact with and provides option-focused information without distracting them from the many features available as in the home screen (a).



(a) Home screen (b) Map panel (c) Mitigation panel

Fig. 10. Screen of mobile application

The application/UI system monitors and controls systems through an automation process and Android/Web-based communication system controls the smart IoT-enabled drip irrigation system using an Android phone from anywhere according to Jain [12]. In a system designed for multi-hazard risk evaluation, it is critical to understand the areas that can potentially experience landslides and the risks that the population, infrastructure, and economic activities may face. This study designed a user usability test as a viable method to improve the usability of disaster mobile apps. The findings revealed that user performance differed by group, with rescuers becoming more efficient. Despite the high level of satisfaction, improved usability is still needed to ensure the app can be used effectively in an emergency. The study found that users of disaster mobile apps fall into three categories: disaster victims, rescue professionals, and other related parties. Abella [1] proof that these data show that the capabilities and demands of users are different, with rescuers being more skilled at using these types of programs. From Aye *et al.,* [5] study show that collaborative decision support framework for hydrometeorological risk management, integrating an interactive web-GIS interface with multi-criteria tools to assist stakeholders in the formulation of potential risk reduction measures and the explanation of the preference criteria for the selection of such measures. Due to the rapid development of modern web, GIS, and spatial information technologies, risk information can now be conveyed to the wider public, facilitating the participation of various stakeholders in collaborative decision-making. According to Jeong and Cheong [14] natural disaster hazard mapping using a web GIS-based system incorporates such an approach to enable users to share disaster information and the results of disaster risk assessment.

8. Conclusion and Future Recommendation

With a series of advantages and models built, several things can be improved in the design process, such as selecting relevant data, analysis methods, and service features that can be presented as a more interactive mobile application. This includes assessing the weight and score of the parameters that form the landslide potential, which is very sensitive on a micro-scale and influenced by the study area's characteristics and expert assessment.

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