PROGRESS IN ENGINEERING APPLICATION AND TECHNOLOGY
e-ISSN: 2773-5303

PEAT

Vol. 5 No. 1 (2024) 122-137
https://publisher.uthm.edu.my/periodicals/index.php/peat

Water Level Monitoring System User Interface for Flood Forecasting

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DOI: https://doi.org/10.30880/peat.2024.05.01.013

Article Info

Received: 28 December 2023
Accepted: 17 January 2024
Available online: 15 June 2024

Keywords

flood, user-interface, reliable data , alert system, MIT App Inventor , Google Sheets , Apps Script, ThingSpeak, predictive analytics.

Abstract

Floods are one of the most common natural disasters in Malaysia, occurring nearly every year, particularly during the monsoon season. Floods affected the entire state of Johor in March 2023. The research focuses on three main objectives: designing a user-friendly interface, ensuring reliable data, and developing an effective alert system for critical water levels. Leveraging contemporary technologies like MIT App Inventor, Google Sheets, Apps Script, and ThingSpeak, the system facilitates real-time monitoring and predictive analytics. The study details the systematic integration of these technologies, shedding light on the design process, data integration, and user interface development. Special emphasis is placed on addressing water resource management challenges and flood mitigation through technological innovation, illustrated by project flowcharts, block diagrams, and system flowcharts. Results demonstrate the system's effectiveness in collecting, processing, and displaying water level data, along with timely alert functionalities. The study's significance extends to policymakers, engineers, and academics involved in water resource management, offering a foundational framework for deploying monitoring systems in flood-prone areas. The conclusion reflects on project accomplishments and provides future recommendations to advance water level monitoring systems for proactive flood management.

1. Introduction

In recent years, floods are a common cause in material, financial, and even human loss. Floods are one of the most common natural disasters in Malaysia, occurring nearly every year, particularly during the monsoon season. Floods affected the entire state of Johor in March 2023. Floods caused by rivers flowing into the mainland inundated many areas, ruined buildings, blocked off important highways, and restricted the delivery of basic services such as water, food, and health care services [1].

The purpose of this study was to improve the system of water level monitoring by using MIT App Inventor. The water level monitoring system user interface for flood forecasting was given named as Gezeiten Application. It is a piece of technology that uses cloud data to warn people about floods. The place is a low-lying plain in Panchor and is where the Sungai Muar River runs. The rest of the land around Sungai Muar is higher than Panchor. This includes Bukit Kepong, Muar. A week goes by when there is not a drop of rain, yet in March 2023 Sungai Muar overflowing causes a river flood in Panchor. The figure 1 as showed the different level of elevation of Bukit Kepong and Panchor. The residents of Sungai Muar were unprepared for the water overflow that resulted from the continuous rain in the higher region next door, which caused the water to overflow owing to gravity. A significant number of residents are enduring profound losses and may develop psychological wounds.

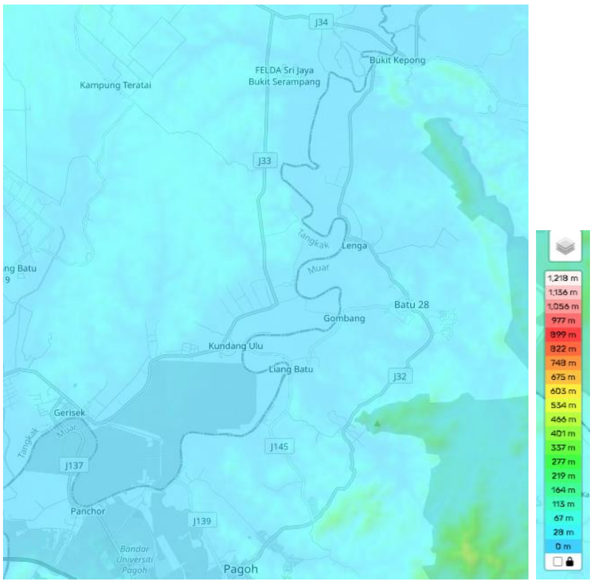

Fig. 1 *Shows the different level of elevation of Bukit Kepong and Panchor*

In response to the imperative challenge of flood monitoring in regions influenced by topographical factors, the Gezeiten Application emerges as an indispensable solution. Distinguished by its user-friendly interface, the application facilitates seamless interaction and ensures real-time access to data. It efficiently retrieves pertinent information from the Water Level Monitoring System tailored for plain areas impacted by topography, solidifying its pivotal role in addressing this critical issue.

The primary goal of this project is to develop a user-friendly interface for a water level monitoring system in plain regions affected by topography. To achieve this, specific objectives have been outlined, including the design of an interface that is easy to use and navigate for efficient interaction with the water level monitoring system. Additionally, the project aims to ensure the reliability of the system's generated data and to evaluate the user usability of the Gezeiten application, emphasizing a comprehensive assessment of its user-friendliness and effectiveness in addressing the challenges of water level monitoring in topographically influenced areas.

To achieve the outlined objectives, this project's scope includes the development of a user interface for a water level monitoring system, specifically designed to accurately monitor water levels in plain regions impacted by topography. The system will employ sensors to collect real-time data on water levels, presenting the information on the user interface. The user interface is intended to offer users seamless access to real-time and historical water level data, along with other pertinent information, in an intuitive and user-friendly manner. The design will prioritize responsiveness, accessibility, and ease of use, allowing users to access the system effortlessly from tablets and smartphones. Additionally, the user interface will be crafted to provide users with valuable insights and trends on water levels in plain areas affected by topography, empowering them to make informed decisions concerning water management.

2. Related Previous Project Study

2.1 Web-Based Platform for River Flood Monitoring

The web-based platform was created to make interactive visualisations, inundation maps, and real-time flood and stream conditions easily accessible. The platform incorporates data management, analysis, modelling, mapping, visualisation, and information sharing capabilities with the goal of improving environmental monitoring and forecasting. The prototype presently shows historical and real-time rainfall, outflow, and water level readings, as well as flood inundation maps, and it focuses on the Portuguese Mondego River, particularly the riparian zones close to Coimbra City. The platform may be accessible via a variety of devices with limited bandwidth capabilities and was created utilising the DHI MIKE OPERATIONS framework. Incorporating weather radar data, meteorological forecasts, and flood predictions from hydrological and hydraulic models are some future advances.

The system architecture consists of component communication, a server-side application for database administration, and a sophisticated web application interface for user visualisation and interaction. The user experience is enhanced by the use of AJAX technology, which optimises data transit between the server and client-side. Through application interfaces and web services, the platform combines numerous data sources and services, enabling adaptability to varied geographic locations. The current version is built upon the DHI MIKE OPERATIONS framework, which comes with a spatial database, online and desktop applications for data visualisation and analysis, and a workbench for seasoned users to set up processes and data reporting. Users can monitor and simulate flood scenarios because to the platform's effective visualisation of specific data, including GIS layers, river water levels, reservoir inflows and outflows, and rainfall readings.

The web-based prototype platform showed off its capacity to provide quick access to interactive visualisations, inundation maps, and real-time flood and stream conditions. The Portuguese Mondego River was the subject of the case study, which provided a single interface for monitoring water levels and flash floods. The platform aids public flood preparation while also supplying decision makers with real-time data from geosensors and flood forecasting algorithms. The platform's capabilities will be expanded, further increasing its value for flood monitoring and forecasting, via the integration of new data sources and models, such as weather radar data, meteorological predictions, and flood forecasts [2]. Figure 2 was showed the platform of user interface.

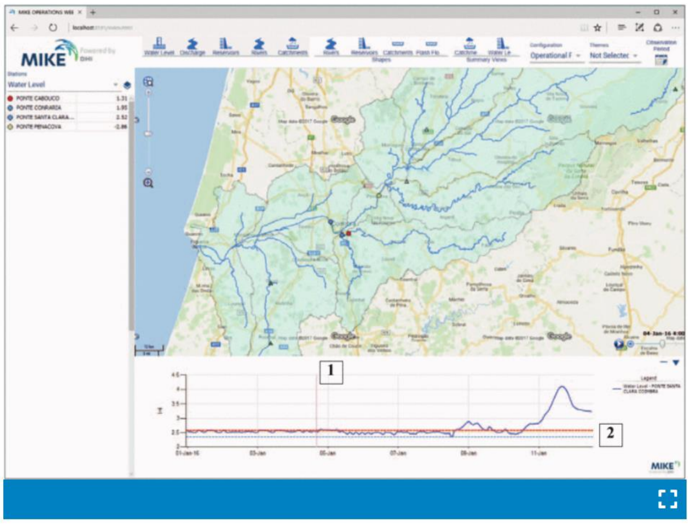

Fig. 2 *Platform's user interface. 1) Vertical bar representing the current time. 2) Horizontal lines representing critical levels.*

2.2 Flood Monitoring System (MyFMS)

In order to reduce the damage caused by floods in Malaysia, a system called the Flood Monitoring System (MyFMS) was created. Both hardware and software elements are part of the system. The system's technology measures changes in water level using sensors that are strategically positioned in places like riverbanks or low-lying regions. The 24-hour Control Center receives and processes the acquired data before compiling, evaluating, and storing it in a database.

On the software side, Visual Basic 6.0 is used to create an application with a graphical user interface (GUI). This program makes it possible to see changes in water level, making monitoring and analysis simple. Additionally, an operating system based on Linux is used to construct an SMS gateway server. In the case of an alert circumstance, this server notifies the appropriate employees via sending alert messages.

The main objective of the Flood Monitoring System (MyFMS) is to enable local authorities to respond quickly and take measures to reduce flood damage. The system intends to provide a methodical approach for flood monitoring and response by employing sensors, data processing, and alarm alerts.

The Flood Monitoring System (MyFMS), in general, is essential for supporting proactive flood management. The technology aids local authorities in making knowledgeable choices and putting into place efficient measures to lessen the impact of floods by continually monitoring water levels and sending out timely notifications [3]. Figure 3 was showed the basic flood monitoring system.

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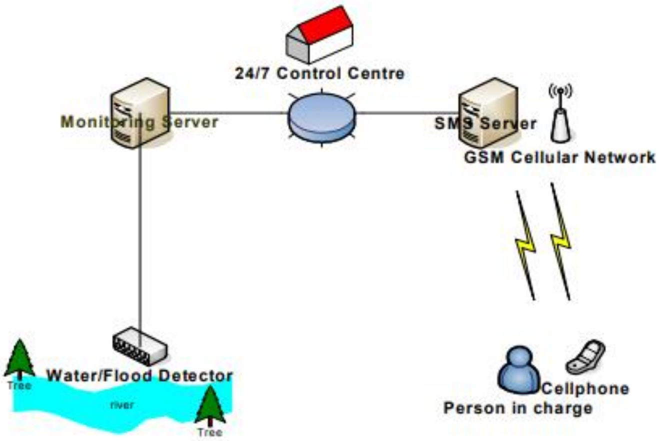

Fig. 3 *Basic Flood Monitoring System*

2.4 The Development of Visual Dashboard For River Monitoring System

The requirement for real-time monitoring of river water levels prompted the creation of an Internet of Things-based water monitoring system as a solution to the problem. The tedious, time-consuming, and labour-intensive conventional ways of determining the quality of water. To gather and send continuous and real-time data to a monitoring station, the suggested system makes use of wireless technologies, microcontrollers, and sensors. The system focuses on measuring water depth and velocity, two factors that are important for managing water resources and monitoring floods. The gathered information is saved in a cloud database and made accessible to users with internet connection through an online dashboard or GUI.

Ultrasonic sensors for measuring water depth and a water flow sensor for detecting velocity are both included in the system's hardware architecture. In order to reduce inaccuracies brought on by fish and extraneous objects, the depth sensor is positioned above the water's surface. By rotating an internal propeller, the velocity sensor determines the rate of water flow. The Node-RED platform receives the data the sensors have generated and processes it before storing it in an InfluxDB cloud database. Users are given an easy and user-friendly interface to monitor the characteristics of the river thanks to the visualisation of the recorded data on a Grafana dashboard.

The system's precision and efficiency are shown by experimental findings. The system's capacity to display water parameter data in real-time was shown by the data acquired by the sensors, which was saved in the InfluxDB database and displayed on the Grafana dashboard. In general, the water monitoring system that has been provided provides a solution that is dependable and effective for real-time river monitoring. In addition, the system has the potential for additional advancements, such as the incorporation of machine learning methods for the identification of anomalies in the water quality [4]. Figure 4 was showed the visual dashboard or remote monitoring system.

Fig. 4 *Visual Dashboard or Remote Monitoring System*

Table 1 *Comparison of existing project*

Tittle	Featuring	Limitation Of Project	Scope
Web-Based Platform for River Flood Monitoring	The objective of this project is to provide a web-based platform with a variety of functions for river flood monitoring. It could involve predictive modelling, historical data analysis, real-time data visualisation, and even collaboration tools for stakeholders. The platform is designed to provide an easy-to-use interface for obtaining and evaluating data on rivers.	The need for dependable internet access and data hosting infrastructure can be one of them. When managing sensitive information on floods and water resources, it may also be necessary to provide serious thought to data security and privacy procedures.	A complete online platform for river flood monitoring, data processing, and decision-making is developed.
Flood Monitoring System (MyFMS)	It was made so that floods could be tracked and managed. To keep track of rainfall, weather, and river water levels, it incorporates a variety of sensors and technology. To forecast the possibility of flooding, the gathered data is processed and analysed. The project may incorporate alarm systems and communication routes to inform stakeholders.	A significant sensor network, dependable data transmission, and precise prediction models may all be required. The efficacy of the system depends on the reliability of the flood prediction algorithms, as well as the quality and timeliness of the data that are being gathered.	In order to allow efficient flood monitoring and response, it includes the creation of a complete system that combines data gathering, processing, and communication components.
The Development of Visual Dashboard for River Monitoring System	It focuses on creating a visual dashboard that offers data visualisation of numerous river metrics, including water level, velocity, and other pertinent elements, in real-time. It seeks to provide the facts in a clear and approachable way so that users may make informed decisions.	Data collected and displayed by the visual dashboard project may be restricted. It is dependent on the accessibility and dependability of IoT-based microcontrollers and sensors. To maintain data integrity and compatibility with new technology, the project may need ongoing maintenance and upgrades.	The creation and implementation of the visual dashboard, with an emphasis on real-time data visualisation for river monitoring purposes, is at the core of this project.

Based on previous studies, multiple studies related to Gezeiten Technology Application project have been conducted. According to the previous studies, each project uses different type of sensors, software and some of the projects contributed both software and hardware in their projects and cloud storage to store data. Moreover, some of the projects use algorithm for route suggestions. However, this project will use MIT app inventor software to create this Gezeiten Technology Application to implement route suggestion for the users.

3. Methodology

The project initiates with the design phase, systematically progressing through key stages to develop a user-friendly interface for a water level monitoring system. Comprehensive requirements, covering the user interface, data reliability, and usability evaluation criteria for the Gezeiten application, are identified, and documented. Integration of data is achieved by connecting ThingSpeak with Google Sheets using Apps Script for efficient storage. The user-friendly interface is crafted using MIT App Inventor, integrated with ThingSpeak to display real-time water level data. A reliability check is implemented to ensure data reliability, with the process either advancing to usability evaluation or looping back for troubleshooting and data enhancement based on the

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outcome. Usability tests are conducted, and user feedback informs iterative design improvements. Figure 3.1 represents the project flowchart.

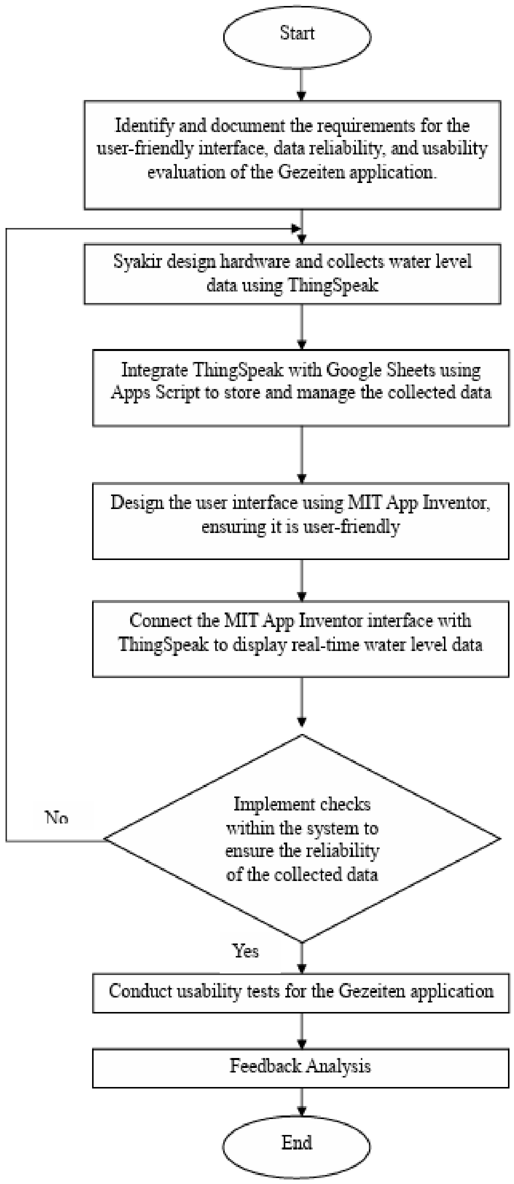


Fig. 5 *The project flowchart*

3.1 Block Diagram

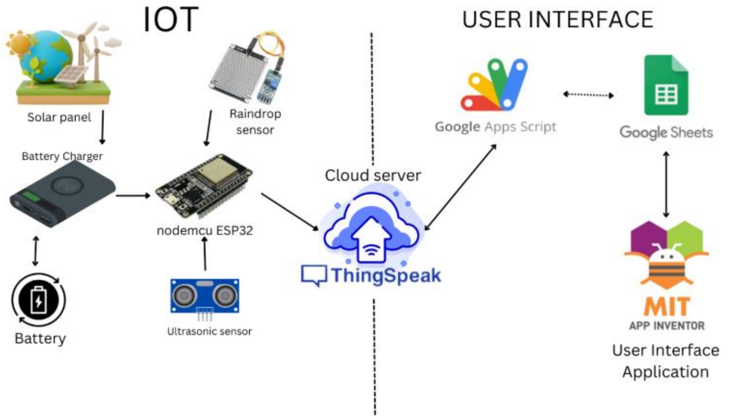


Fig. 6 *Block Diagram of Water Level Monitoring System User Interface for Flood Forecasting*

The block diagram illustrates the components of a water level monitoring system. The NodeMCU ESP8266 serves as the central microcontroller in the Gezeiten Technology Sensor Nodes, integrating sensors such as the Ultrasonic and Raindrop Module along with a power supply. Both nodes are powered by rechargeable batteries recharged through solar panels and connect to the ThingSpeak cloud system. This system facilitates real-time data transmission for monitoring and alerts. The water level monitoring system's user interface utilizes interconnected components visualized through a block diagram. Real-time data from ThingSpeak is received and processed by Google Apps Script, then transferred to Google Sheets for storage. MIT App Inventor creates a user-friendly interface using organized data, allowing end-users to access and interact with real-time water level information. The seamless integration of components, illustrated in Figure 3.2, ensures efficient processing, storage, and presentation of water level data in the system.

3.2 System Flowchart

The system initiates by collecting water level data, setting the foundation for subsequent stages. MIT App Inventor integrates with ThingSpeak for real-time data retrieval, while Google Sheets ensures data integrity through various tasks, aided by automation through Apps Script. Shifting focus to user experience, MIT App Inventor designs a user-friendly interface with a visual dashboard for effective data representation. A user usability evaluation identifies areas for im provement based on feedback, guiding the planning of enhancements in the final phase. The iterative process concludes with Figure 7, illustrating the system flowchart of the User Interface for the Water Level Monitoring System for Flood Forecasting, aimed at delivering an efficient and user-centric solution.

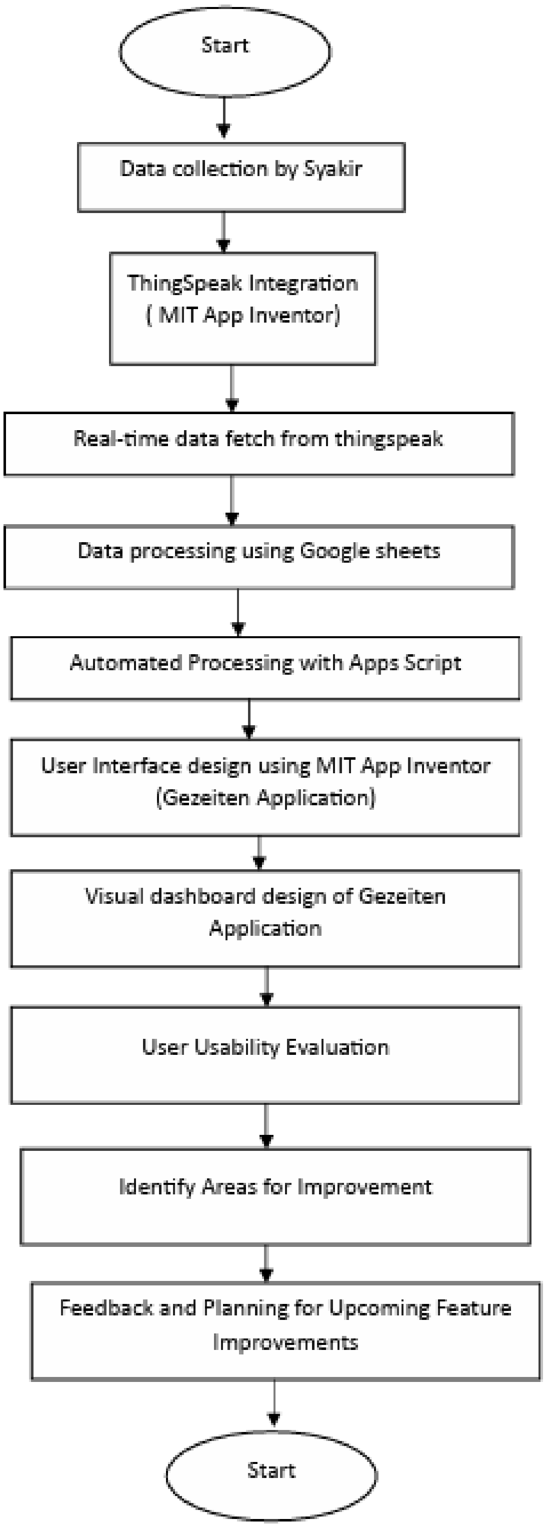
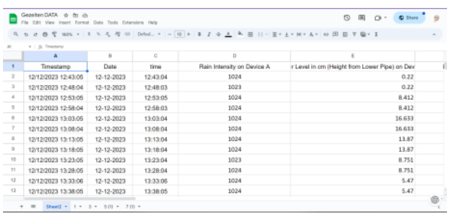


Fig. 7 *The system flowchart*

3.3 Project Software

Table 2 *List of software*

Software	Description
Microsoft Office	Microsoft Office is a comprehensive collection of productivity software developed by Microsoft. It includes popular programs such as Word, Excel, PowerPoint, Outlook, and Access, which have become the industry standard for various tasks like document creation, spreadsheet analysis, presentation design, email management, and database building. Additionally, Microsoft Access allows users to construct and manage databases, providing a graphical interface for creating reports, tables, forms, and queries [6].
ThingSpeak	ThingSpeak is an Internet of Things (IoT) platform and data analytics service offered by MathWorks that enables users to gather, examine, and visualize data from connected devices. It provides an API for simple IoT device integration and makes real-time data storage, retrieval, and analysis possible. This makes it an invaluable tool for researchers and developers who are creating IoT solutions and running tests across many domains [7]
MIT App Inventor	MIT App Inventor is a freely available platform for constructing mobile applications [9]. It enables users to easily create applications by visually arranging and manipulating objects. These applications are compatible with the Android operating system. The primary goal of MIT App Inventor is to make mobile app creation accessible to a wider audience. The application's behaviour is achieved by assembling blocks in a programming language that is based on visual blocks. The system's user-friendly interface has greatly contributed to its widespread adoption, resulting in over 10 million individuals worldwide utilising MIT App Inventor as a powerful tool for creating a staggering 43 million applications.
Google Sheets 	Google Sheet is powerful enough to process data at a certain capacity and flexible enough to visualize data [10]. Google Sheets is an online-based application developed by Google [11]. The application serves to create and format spreadsheet documents in real time via the internet network [12]. Creating dashboards as well as data storage is easier with the Google Sheets application [13]. Many functions and formulas make it easier to process data; even in Google Sheets, programming scripts can also be inserted if needed [14]. Google Sheets is more efficient in terms of use because it is cloud-based, compared to traditional applications installed on the desktop even though it is more familiar [15].

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3.4 Water level monitoring system user interface for flood forecasting design.

The Water Level Monitoring System for Flood Forecasting features an interactive graphical user interface (GUI) named Gezeiten Technology. The name "Gezeiten," meaning "tides" in German, reflects the technology's functionality. Gezeiten offers a visually intuitive and dynamic interface for users to monitor water levels and access data relevant to flood forecasting. Developed through MIT App Inventor, the customized user interface enhances the overall user experience by providing a cohesive and comprehensible framework for visualizing and interacting with real-time data. Figure 8 showcases both the Gezeiten logo and the design of the Gezeiten application dashboard, emphasizing its visually appealing and user-friendly nature.

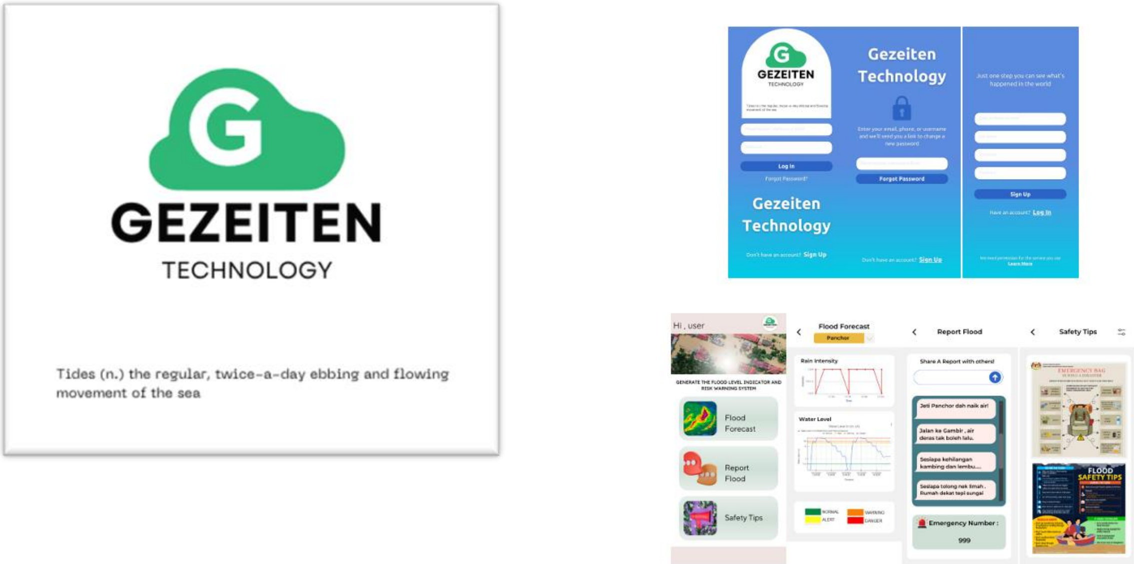


Fig. 8 *(a) Gezeiten logo (b) The design of Gezeite Application dashboard*

4. Result And Analysis

This chapter aims to present and discuss the results and findings of two integrated projects: the "Water Level Monitoring System for Plain Area Affected by Topography" and the "Gezeiten Application" focusing on the user interface. The water level monitoring system, designed for flood-prone areas, utilized the ESP8266 for data upload and communication, powered by a solar panel for self-recharging. Evaluation focused on system efficiency and accessibility, with data presented visually in tables and graphs. Simultaneously, the Gezeiten Application aimed to provide a user-friendly platform for seamless access to water level data. Developed with MIT App Inventor, it offers a dynamic and intuitive experience, visually representing real-time water level information. This combined results and discussion section explores the synergy between the technical aspects of the monitoring system and the user interface prowess of the Gezeiten Application. Real-time data from the monitoring system is integrated into the Gezeiten user interface, facilitating easy access, and understanding. The discussion emphasizes the efficiency, reliability, and user experience of both components, highlighting how they collaboratively provide a comprehensive solution for monitoring water levels in flood-prone areas. The Gezeiten Application's user-friendly interface acts as a bridge, enabling smooth user interaction with monitoring system data, ensuring a holistic and effective approach to water level monitoring and flood forecasting.

4.1 Data Analysis

The data analysis procedure for the Water Level Monitoring System involves a collaborative coordination of key platforms. Real-time sensor water level data is effectively communicated and stored, utilizing ThingSpeak as the primary cloud repository. Subsequently, Google Sheets becomes the central hub for data analysis, leveraging its cloud-based spreadsheet features for group editing, organized data, and analytical tools. Automation and extension of Google Workspace applications are achieved through Apps Script, which meticulously processes and manipulates water level data within Google Sheets, ensuring a streamlined and effective analysis process.

4.1.1 Device Testing And Send Data To Thingspeak

In a 2-hour experiment, devices were placed 5 km apart from a river at two locations to study the correlation between distance and the time it takes for river water to peak. The primary aim was to assess water levels and observe the natural river flow during low and high tides. Figure 9 illustrates the deployment of devices at these locations.

Fig. 9 *Device deployed at the respective locations*

Data collection was performed via ThingSpeak, a cloud-based IoT platform, serving as the primary repository for real-time water level data from sensors. ThingSpeak's robust capabilities enable efficient data transmission and storage. Figure 10 visually represents each field as a water level reading on the ThingSpeak channel.

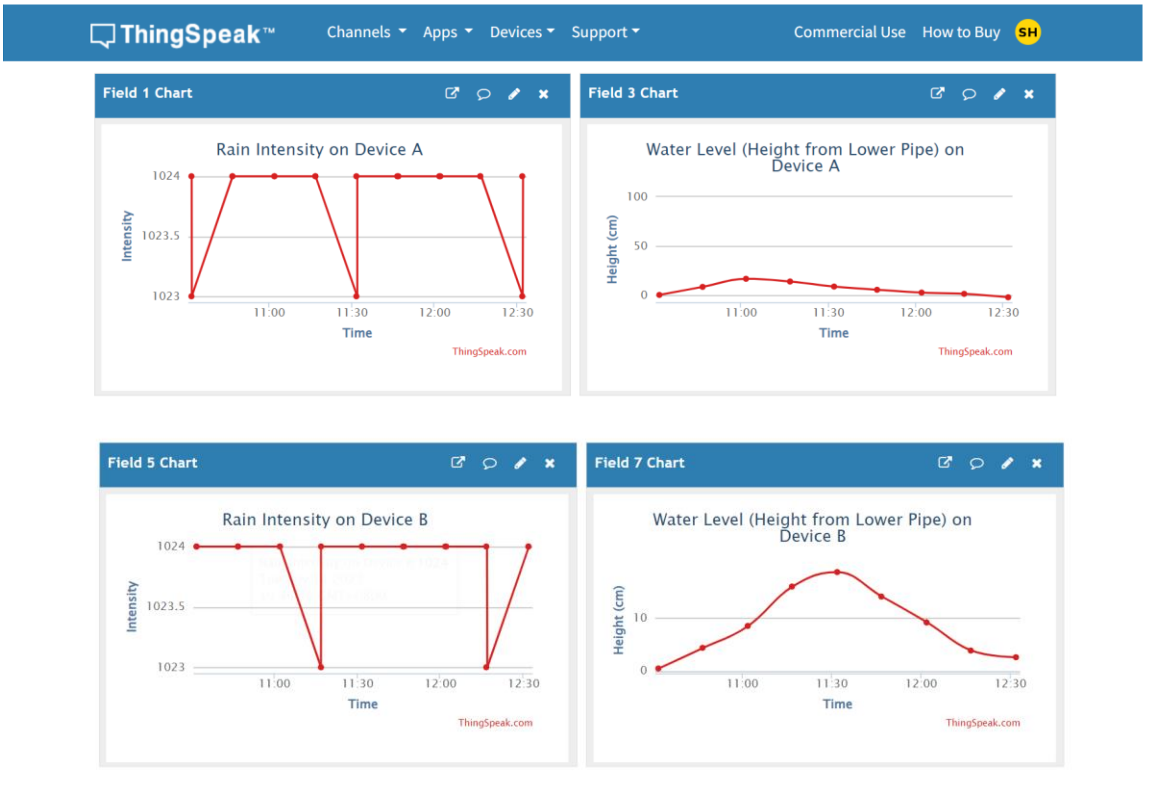


Fig. 10 *shows each field represented a water level readings on ThingSpeak channel*

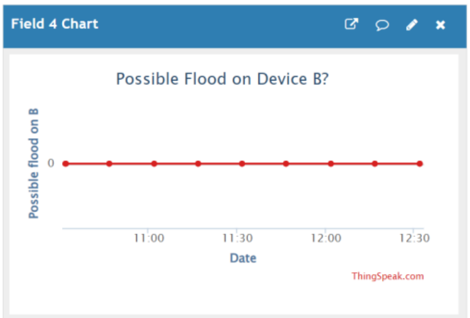
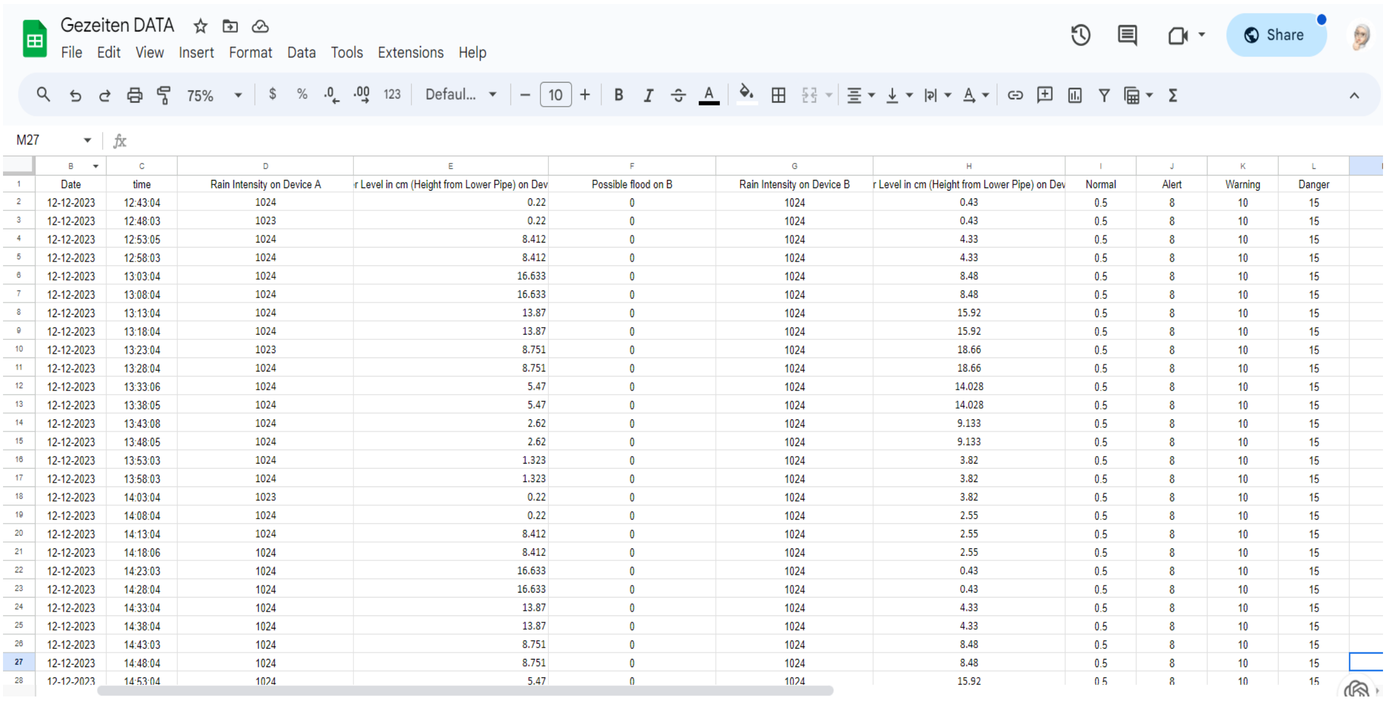


Fig. 10 *continue*

4.1.2 Gezeiten Application Data Sheet

Following the initial data collection phase, Google Sheets becomes the central hub for thorough data analysis. This cloud-based spreadsheet application provides a versatile platform for collaborative editing, allowing multiple stakeholders to contribute to and refine the dataset. Google Sheets incorporates various analytical tools to derive meaningful insights from the collected data, as depicted in Figure 11, which illustrates the data fetched from ThingSpeak.



	Date	time	Rain Intensity on Device A	r Level in cm (Height from Lower Pipe) on Dev	Possible flood on B	Rain Intensity on Device B	r Level in cm (Height from Lower Pipe) on Dev	Normal	Alert	Warning	Danger
2	12-12-2023	12:43:04	1024	0.22	0	1024	0.43	0.5	8	10	15
3	12-12-2023	12:48:03	1023	0.22	0	1024	0.43	0.5	8	10	15
4	12-12-2023	12:53:05	1024	8.412	0	1024	4.33	0.5	8	10	15
5	12-12-2023	12:58:03	1024	8.412	0	1024	4.33	0.5	8	10	15
6	12-12-2023	13:03:04	1024	16.633	0	1024	8.48	0.5	8	10	15
7	12-12-2023	13:08:04	1024	16.633	0	1024	8.48	0.5	8	10	15
8	12-12-2023	13:13:04	1024	13.87	0	1024	15.92	0.5	8	10	15
9	12-12-2023	13:18:04	1024	13.87	0	1024	15.92	0.5	8	10	15
10	12-12-2023	13:23:04	1023	8.751	0	1024	18.66	0.5	8	10	15
11	12-12-2023	13:28:04	1024	8.751	0	1024	18.66	0.5	8	10	15
12	12-12-2023	13:33:06	1024	5.47	0	1024	14.028	0.5	8	10	15
13	12-12-2023	13:38:05	1024	5.47	0	1024	14.028	0.5	8	10	15
14	12-12-2023	13:43:08	1024	2.62	0	1024	9.133	0.5	8	10	15
15	12-12-2023	13:48:05	1024	2.62	0	1024	9.133	0.5	8	10	15
16	12-12-2023	13:53:03	1024	1.323	0	1024	3.82	0.5	8	10	15
17	12-12-2023	13:58:03	1024	1.323	0	1024	3.82	0.5	8	10	15
18	12-12-2023	14:03:04	1023	0.22	0	1024	3.82	0.5	8	10	15
19	12-12-2023	14:08:04	1024	0.22	0	1024	2.55	0.5	8	10	15
20	12-12-2023	14:13:04	1024	8.412	0	1024	2.55	0.5	8	10	15
21	12-12-2023	14:18:06	1024	8.412	0	1024	2.55	0.5	8	10	15
22	12-12-2023	14:23:03	1024	16.633	0	1024	0.43	0.5	8	10	15
23	12-12-2023	14:28:04	1024	16.633	0	1024	0.43	0.5	8	10	15
24	12-12-2023	14:33:04	1024	13.87	0	1024	4.33	0.5	8	10	15
25	12-12-2023	14:38:04	1024	13.87	0	1024	4.33	0.5	8	10	15
26	12-12-2023	14:43:03	1024	8.751	0	1024	8.48	0.5	8	10	15
27	12-12-2023	14:48:04	1024	8.751	0	1024	8.48	0.5	8	10	15
28	12-12-2023	14:53:04	1024	5.47	0	1024	15.92	0.5	8	10	15

Fig. 11 *Fetch data from ThingSpeak*

Following data retrieval from ThingSpeak, the subsequent step includes generating graphical charts to visually convey and interpret the collected information. This visual representation enhances data comprehension by offering a graphical context, revealing patterns or trends that may be less discernible in numerical form. The charts serve as effective communication tools, aiding users in understanding complex relationships or variations within the dataset. Figure 12 depicts a line chart representing water levels on devices A(a) and B(c), as well as rain intensity on devices A(b) and B(d).

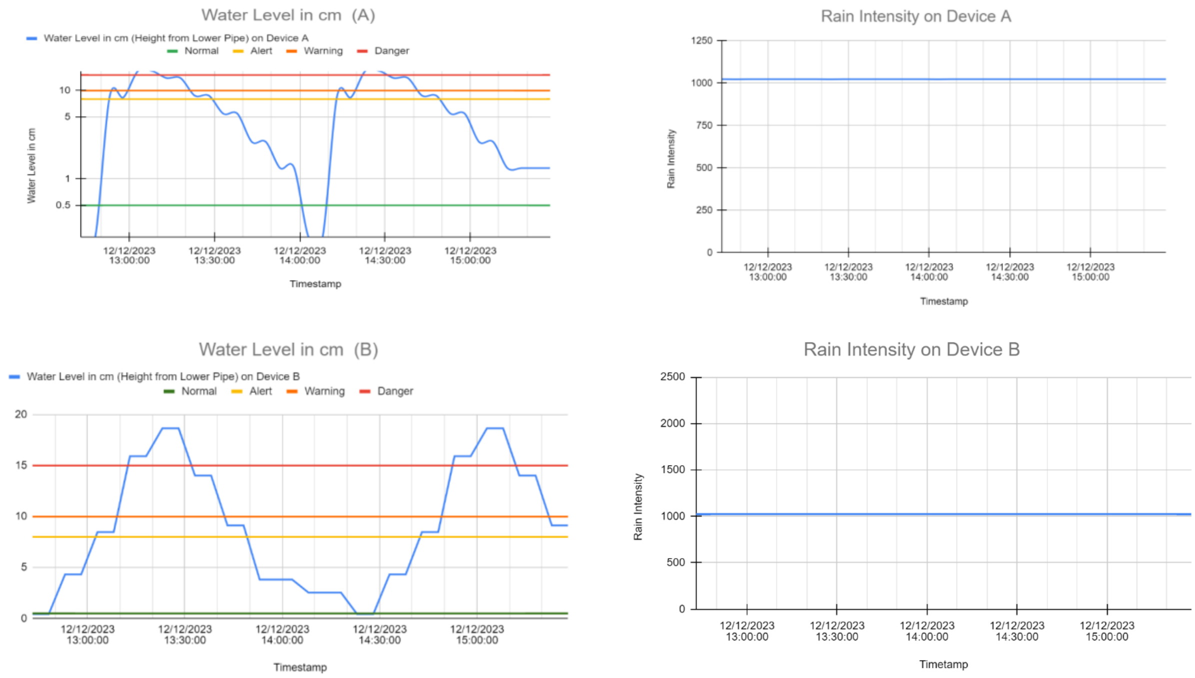


Fig. 12 *(a) Water Level (Height from Lower Pipe) on Device A (b) Rain intensity on Device A (c) Water Level (Height from Lower Pipe) on Device B (d) Rain Intensity on Device B*

The collected data was compared with Figure 4, which represents the hydrograph of the Muar River from Jabatan Pengairan Dan Saliran (JPS) Malaysia. This comparative analysis aids in comprehending the frequency of river flooding during high tide periods. Figure 13 specifically illustrates the hydrograph of the Muar River from JPS Malaysia.

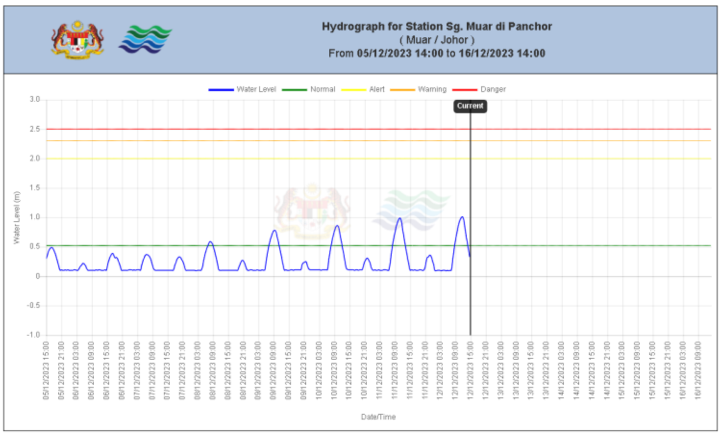


Fig.13 *The hydrograph of the Muar River from Jabatan Pengairan Dan Saliran (JPS) Malaysia*

4.1.3 Gezeiten Application

The culmination of data analysis is manifested in a user interface developed using MIT App Inventor. Leveraging visual block language and real-time testing, this interface creates an intuitive dashboard presenting comprehensible water level data analysis. The user-friendly design enhances the monitoring and interpretation of the analyzed data. Figure 14 displays the Water Level Dashboard on the Gezeiten Technology Application. Ultimately, the integration of ThingSpeak, Google Sheets, and MIT App Inventor offers an effective solution for data collection, analysis, and visualization in the water level monitoring system. This integrated approach, combining cloud-based storage and real-time visualization, enhances the system's functionality and usability, providing users with valuable insights from the collected data.

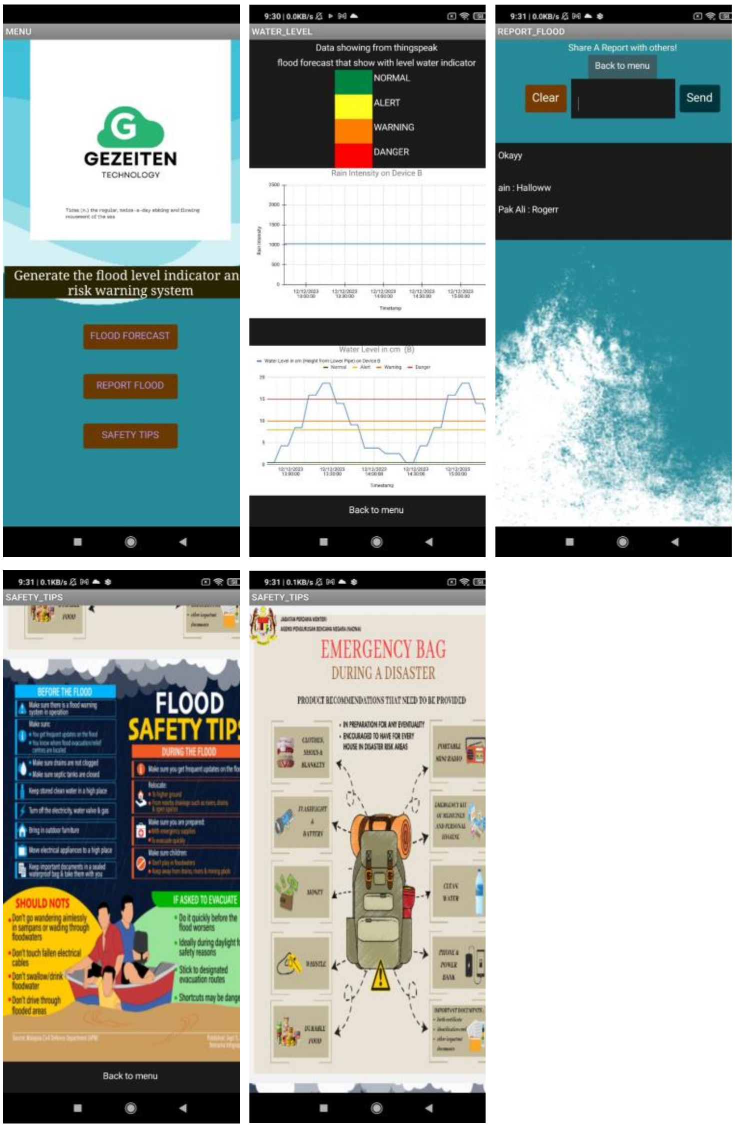


Fig. 14 *Dashboard of Gezeiten Application*

4.2 User Feedback from the satisfaction with Gezeiten Application Questionnaire

The user experience survey conducted with 58 respondents after the successful development of the Gezeiten application's user interface indicates high user satisfaction. Using a 5-point Likert scale, the survey explored aspects like the interface, functionality, and overall performance. Results show a predominantly positive trend, with many expressing a strong inclination to frequently use the Gezeiten application. Positive feedback emphasizes its ease of use, well-integrated functions, and perceived consistency, making it intuitive and accessible. While a minority noted some complexity, the overall sentiment suggests high satisfaction and potential widespread acceptance. The survey also indicates a strong likelihood of users recommending the Gezeiten application to others, affirming its value in water level monitoring for topographically impacted regions. Overall, these findings confirm the success of the Gezeiten application in meeting user expectations and establishing itself as a user-friendly and valuable tool.

5. Conclusion and Recommendations

This study introduces the Gezeiten Application, a pioneering Water Level Monitoring System User Interface for Flood Forecasting, addressing crucial issues in flood prediction and management. Positioned at the intersection of real-time monitoring and predictive analytics, the Gezeiten Application represents a cutting-edge solution to climate challenges and disaster preparedness. The system integrates seamlessly with technologies like ThingSpeak, Google Sheets, Apps Script, and MIT App Inventor, forming a robust foundation for real-time monitoring and predictive flood analytics. Positive user feedback emphasizes its user-friendly design, with forward-looking recommendations suggesting potential enhancements. In essence, Gezeiten Technology signifies not only a technological milestone but also a commitment to proactive flood management, aiming to protect communities against the escalating threats of flooding.

The project's findings recommend several enhancements to the flood monitoring application. First, it suggests incorporating customizable alert preferences, empowering users to tailor alerts based on their specific needs. Second, the proposal explores integrating augmented reality (AR) features for an immersive experience, overlaying real-time flood data onto the physical environment. Additionally, the recommendation includes expanding geographic coverage by collaborating globally to monitor a broader range of flood-prone regions. To boost predictive capabilities, the integration of machine learning algorithms is advised, aiming to improve accuracy in flood forecasting for timely and informed decision-making. Lastly, the proposal suggests strengthening collaboration with emergency response agencies to integrate real-time data, ensuring users receive immediate, actionable information during flood events for a more effective disaster response.

Acknowledgement

Authors would like to thank the University Tun Hussein Onn Malaysia especially Faculty of Engineering Technology (Department of Electrical Engineering Technology) for supporting and providing information sources that assisted the research from beginning until everything is completed successfully.

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