Geographic Information System for Mapping Polling Station Locations in Parungkuda District

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Abstract

This study aims to develop a Geographic Information System (GIS) that maps the locations of Polling Stations (TPS) for general elections in Parungkuda District. Through literature review, field observations, and interviews with relevant stakeholders, geographical data such as TPS locations and district boundaries were collected and analyzed. In this research, a web-based information system was developed using Mapbox technology to display interactive mapping of the TPS. The outcome is a system that facilitates the public in finding TPS locations and obtaining information on the number of voters and presidential candidates in each TPS. This research has benefits in terms of mapping and accessing TPS-related information, and it is recommended for further development to be widely used in general elections within Parungkuda District. This GIS can improve the efficiency of the election process and provide ease of access for voters to find the appropriate TPS based on their residence.

Keywords: Mapping, Location Points, Polling Stations, General Elections

Abstrak

Penelitian ini bertujuan untuk mengembangkan Sistem Informasi Geografis (SIG) yang memetakan titik lokasi Tempat Pemungutan Suara (TPS) untuk pemilihan umum di Kecamatan Parungkuda. Melalui metode studi pustaka, observasi lapangan, dan wawancara dengan pihak terkait, data geografis seperti titik lokasi TPS dan batas-batas kecamatan dikumpulkan dan dianalisis. Dalam penelitian ini, dikembangkan sebuah sistem informasi berbasis web menggunakan teknologi Mapbox untuk menampilkan pemetaan TPS secara interaktif. Hasilnya adalah sebuah sistem yang memudahkan masyarakat untuk menemukan lokasi TPS dan mendapatkan informasi terkait jumlah pemilih dan calon presiden di TPS tersebut. Penelitian ini memiliki manfaat dalam pemetaan dan akses informasi terkait TPS, dan direkomendasikan untuk dikembangkan lebih lanjut agar dapat digunakan secara luas dalam pemilihan umum di wilayah Kecamatan Parungkuda. Diharapkan SIG ini dapat meningkatkan efisiensi dalam proses pemilihan dan memberikan kemudahan akses bagi pemilih dalam menemukan TPS yang sesuai dengan tempat tinggal mereka.

Kata-kata kunci: Pemetaan, Titik Lokasi, Tempat Pemungutan Suara, Pemilihan Umum

1. Introduction

Geographic Information Systems (GIS) has expanded in various fields such as mapping, urban planning, natural resource management, conservation, agriculture, transportation, etc. GIS has become increasingly popular with the rapid development of information and telecommunications technology, which is affordable and provides easy access to geographic data through technologies like GPS and satellite imagery. This opens up new opportunities for developing and implementing GIS in various domains [1]. In the current digital and globalized era, GIS continues to evolve and become increasingly important in the effective and efficient management and analysis of geographic data. GIS helps improve decision-making, enhances productivity, reduces risks in various aspects of life, and provides new opportunities for business development and innovation.

In Indonesia, as we approach the 2024 presidential election, GIS is highly beneficial in election planning, implementation, and publication. GIS can assist in determining the distribution and density of Polling Stations (TPS) using markers on Google API, facilitating the division and placement of TPS. Administrative data, population distribution, road networks, and topography can be utilized to facilitate the placement of TPS and regulate their density. Furthermore, web-based GIS facilitates the dissemination of election information to the public [2]. Through web-based GIS, the community can quickly identify the coverage boundaries of TPS and find the nearest TPS. In implementing the 2024 presidential election, integrating GIS with the Internet is crucial, especially in vote counting.

Web-based GIS enables the public to view real-time election results and reduces vote counting or manipulation errors. For example, Parungkuda Subdistrict in Sukabumi Regency, West Java Province, Indonesia, has a large area with 11 villages. In every general election, voting is a crucial stage in determining the outcome [3]. Therefore, a GIS is needed to map the Parungkuda subdistrict area and the locations of TPS within it. With a digital map providing detailed information about TPS locations, the electoral process in Parungkuda subdistrict can become more efficient and effective.

2.   Method

2.1   Research Stages

The research stages refer to the sequential steps carried out in a research study **[4]**. These stages are conducted by the researcher in the Geographic Information System (GIS) for Polling Stations located in Parungkuda Subdistrict, as shown in **Figure 1**.
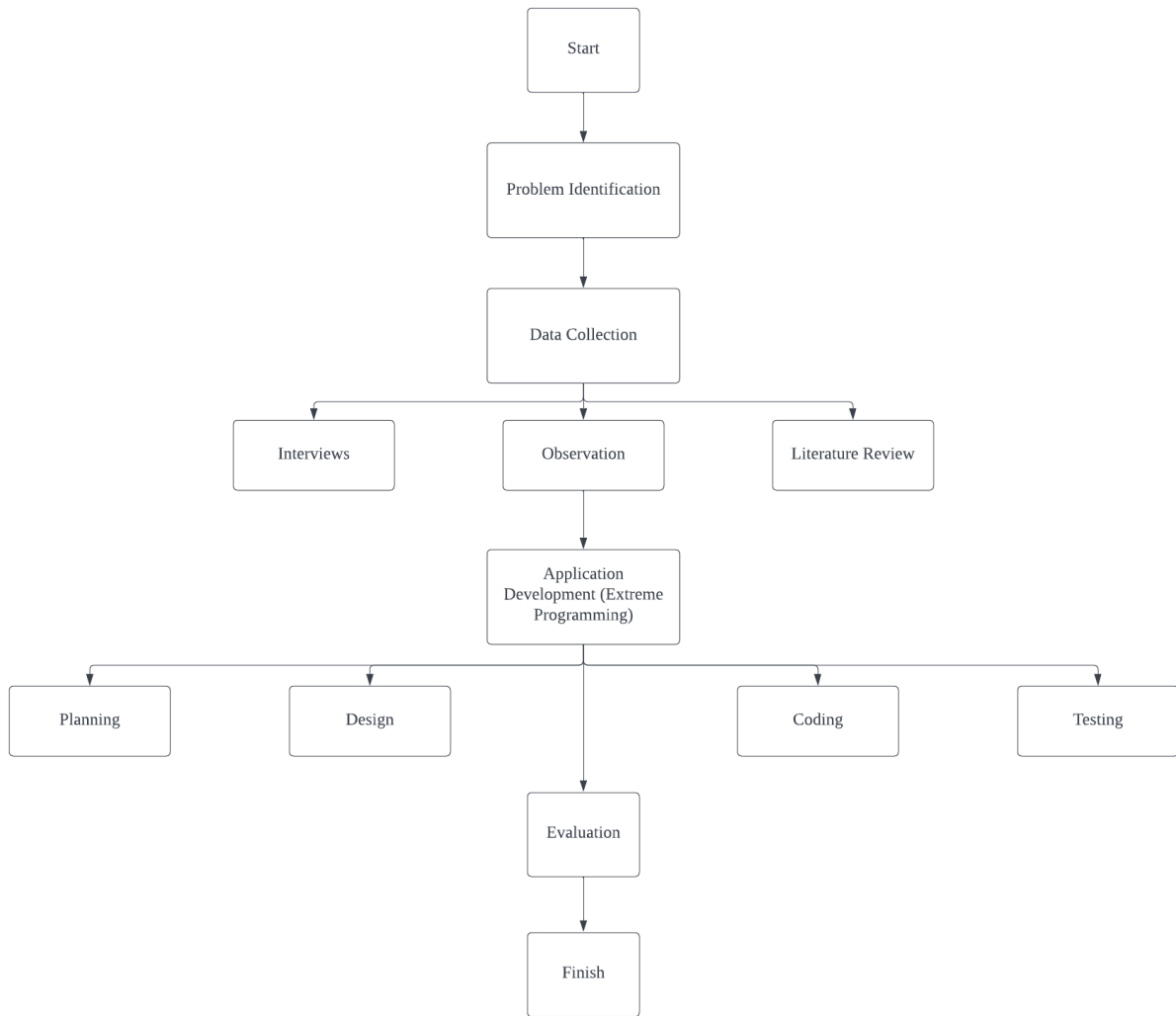
Figure 1. Research Process Flow

2.2   **Data Collection Techniques**

The author applied the following methods or data collection techniques in this study:

a. Interviews

Interviews were conducted by directly speaking with relevant individuals to gather in-depth information. The author posed structured or open-ended questions to understand their perspectives, experiences, and opinions regarding the research topic.

b. Observation

Observation involves directly observing relevant events or situations related to the research. The author carefully observed behaviours, interactions, and conditions. Comment helped the author gain a deeper understanding of the observed situation.

c. Literature Review

A literature review involves searching for and analyzing relevant literature related to the research topic. The author used books, scholarly journals, articles, and other online sources to understand the subject better.

By employing these data collection techniques, the author aimed to gather comprehensive and diverse data to support the research findings and conclusions.

2.3   System Development Method

Extreme Programming (XP) is a commonly used approach in rapid software development. This method was chosen because the developed application requires a fast-paced process through several stages, including Planning, Design, Coding, and Testing [5]. These stages are illustrated in a diagram that can be found in relevant sources is presented on **Figure 2**.
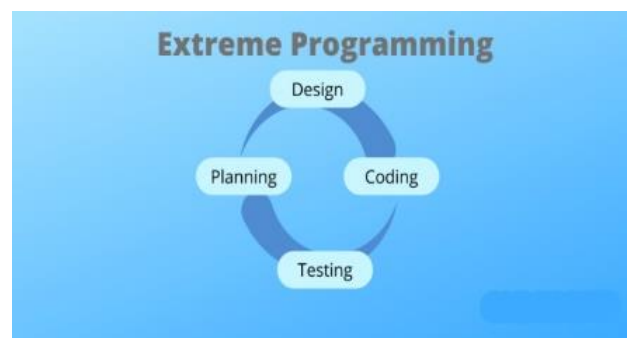
Figure 2. Extreme Programming (XP) Development Methodology

a. Planning

In the planning phase, it begins by gathering requirements that help understand the context of an application. This stage also involves defining the developed application's desired outputs, features, and functions.

b. Design

The specification phase determines the program architecture, interfaces, and other supporting elements. The design stage is described using Use Case Diagrams and Activity Diagrams.

c. Coding

The core concept of the coding phase in Extreme Programming is pair programming, which involves more than one individual writing code together. In this case, the coding is done for a website application using the Mapbox and Laravel frameworks.

d. Testing

The testing phase is when the application is tested to ensure compliance with the design specifications. The testing process involves using Alpha testing techniques, where the application is tested within a predetermined scope defined as the target application.

2.4 System Requirements Analysis

Here are the hardware requirements that the author used during the research is presented on **Table 1**.

Table 1. Hardware Requirements Analysis

No	Tools	Specification
1	Processor	Intel® Core™ i7-1065G7
2	RAM	8GB DDR4
3	Storage	SSD 512GB PCIe SSD Nvme

Software requirements that the author used during is presented on **Table 2**.

Table 2. Software Requirements Analysis

| No	Software	Specification
1	Operating System	Operating System Windows 10
2	Browser	Google Chrome Version 102.0.5005.115 (Official Build) (64-bit)
3	Web Server	Xampp v3.3.0
4	Code Editor	Visual Studio Code
5	Framework	Bootstrap v3.3.6
6	Programming Language	PHP 8.1.17, Javascript, CSS, HTML
7	Database	Mysql Ver 15.1

2.5 Design

Website design involves planning and creating the website's structure, layout, visual design, and functionality. The main objective is to create a positive user experience and meet the desired business goals [6]. In website design using UML (Unified Modeling Language), various

types of UML diagrams such as Use Case, Class, Activity, Sequence, and State diagrams are used to visually depict the system's interactions, structures, activities, and relationships [7].
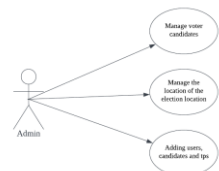
a. Use Case Diagram Design

A Use Case diagram is used in software analysis and design to depict the interactions between actors (external users or other systems) and the system being analyzed [8]. This diagram visually represents the system's functionality and usage scenarios involving actors and use cases. Here is the Use Case diagram used is presented in Figure 3.
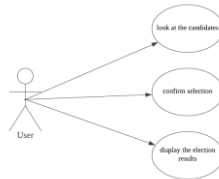
Figure 3. Use Case Diagram User

Use case diagram admin is presented Figure 4.

Figure 4. Use Case Diagram Admin

An activity diagram is a type of diagram used in modelling business processes or workflow of a system. This diagram helps depict the sequence of activities or steps within a process and endow between these activities [9]. Here is the Activity diagram used by the author in the research:

b. Activity Diagram Login
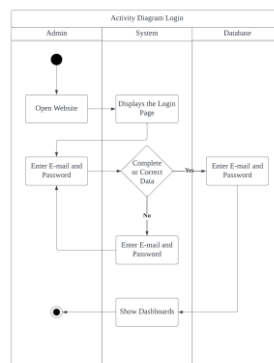
Figure 5. Activity Diagram Login

The Login Activity Diagram illustrates the steps an admin needs to follow to log in. The process starts by opening the application. After that, the admin will be directed to the Login page [10]. The admin is prompted to enter their username and password on the Login form page. If the

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entered password is validated, the admin will log in and be redirected to the dashboard page **[11]**. Activity Diagram Kelola TPS is presented in Figure 6.
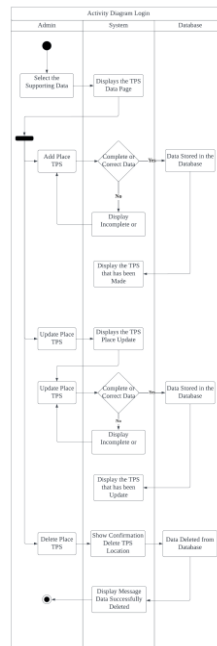

Figure 6. Activity Diagram Kelola TPS

The Manage Voting Station Activity Diagram illustrates an admin's steps to add a voting station location. The process starts by opening the application. After that, the admin will be directed to the voting station data page [12]. On the voting station data form page, the admin is prompted to fill in the voting station details, including the coordinates of the voting station **[13]**. If all the data is filled in correctly, the admin will successfully add the voting station location.

3.   Results and Discussion

In this study, the author aimed to understand various facilities that can support the design of a desired system [14]. The objective of developing this website application is to serve as a tool for mapping the locations of election voting stations (TPS).

3.1 System Implementation

This website page is the main page, allowing users to view various features available in the TPS GIS application. Users can access this page without the need to log in first. Website page is presented in **Figure 7**.
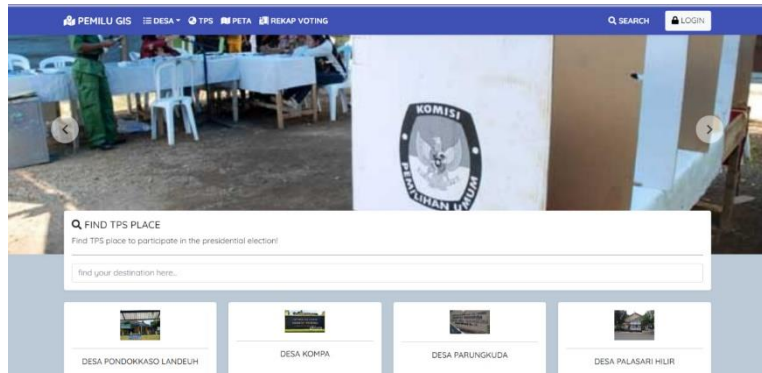
Figure 7. Website Page

The Village page serves to view all the election locations that have been mapped. The category used as an example is the election location category, where users can select the election location category to view all the polling stations (TPS) included in that category. Another feature on the Categories menu is a location search from the user's current location to the intended TPS. Village menu is presented in **Figure 8**.
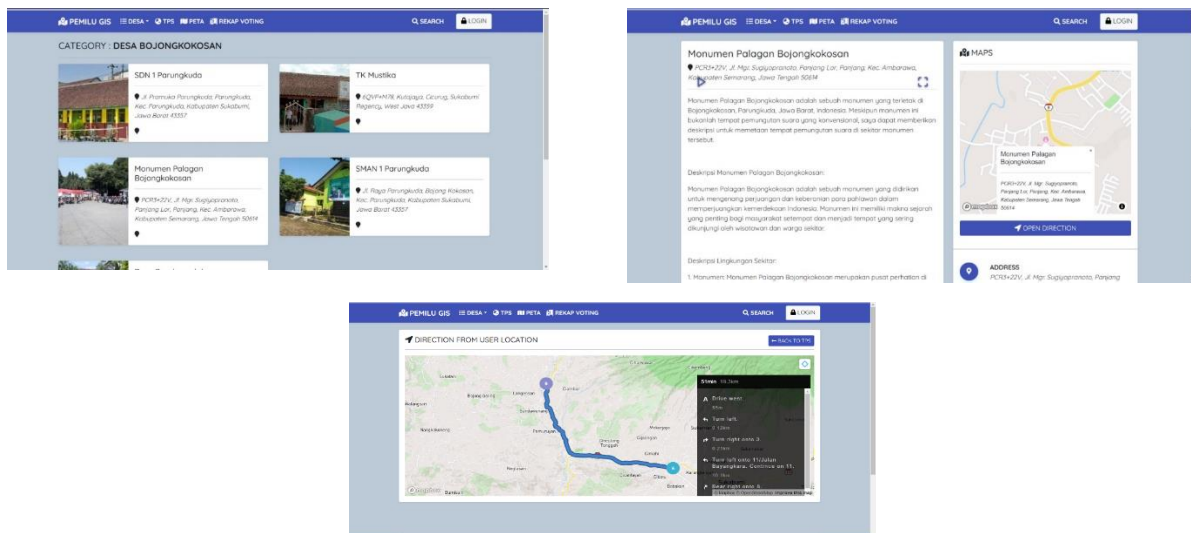

Figure 8. Village Menu Page

The TPS menu page views all the election locations mapped as a Mapbox. Users can view all the election locations on the Places menu, like the Categories menu, and search for places from different polling stations (TPS). The difference is that users can view all sites on the Places menu without selecting a specific category. TPS menu page is presented in **Figure 9**.
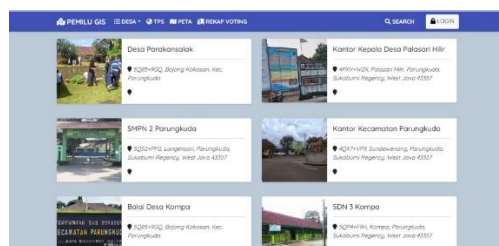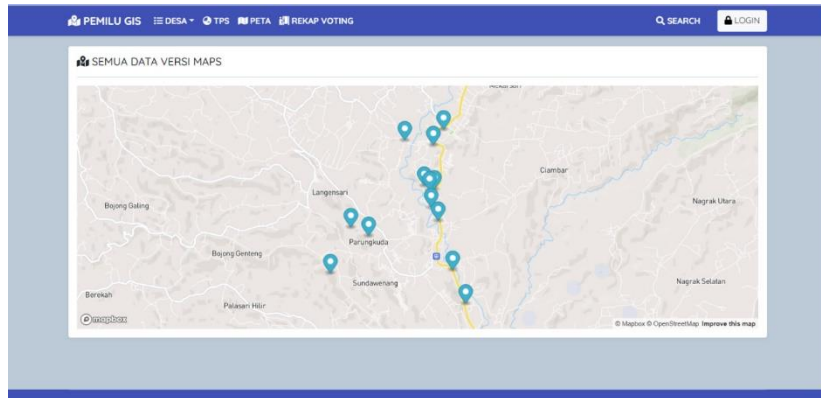

Figure 9. TPS Menu Page

The Maps menu page displays all the mappings in the form of a map view. Users can only view the mappings in a map format on the Maps menu and cannot perform TPS location searches like in the Desa and TPS menus. Its function is to provide users with a comprehensive visual overview of the conducted mappings. Map menu page is presented in **Figure 10**.

Figure 10. Maps Menu Page

The vote recap menu page serves the purpose of viewing the voting results for several presidential candidates. On the Vote recap menu, users will be prompted to log in first, and after that, they can select the desired presidential candidate to vote for. The menu provides users with a platform to participate in the voting process and view the aggregated results of the voting. Vote menu page is presented **Figure 11.**
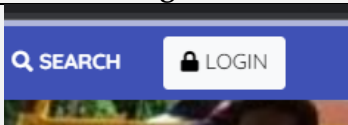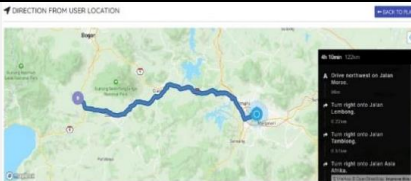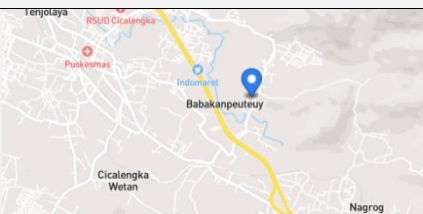

Figure 11. Vote Menu Page
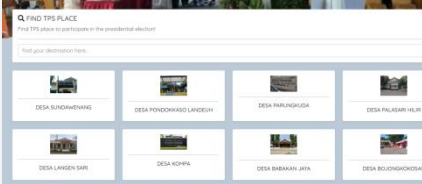
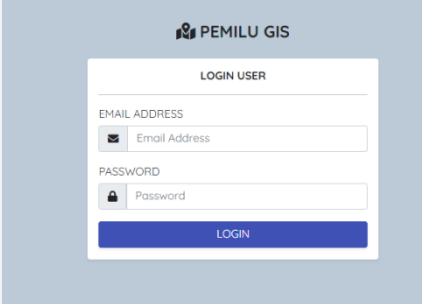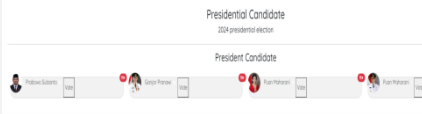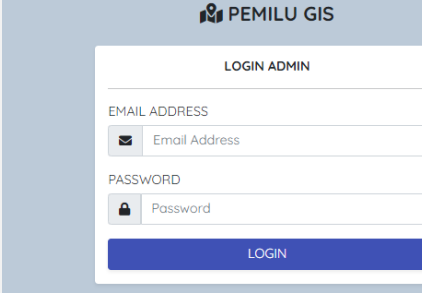Developing a Geographic Information System (GIS) for mapping Polling Station (TPS) locations in Parungkuda District has significantly contributed to enhancing the efficiency and accessibility of the electoral process. Through the integration of GIS technology, individuals can easily search for TPS locations based on their residential addresses. At the same time, election administrators can allocate resources by considering the spatial distribution of TPS. The GIS system also promotes transparency by providing real-time information on the number of voters and presidential candidates at each TPS. However, it is crucial to prioritize data accuracy and

regular updates and provide adequate training to users to ensure optimal utilization of the GIS system. In conclusion, implementing GIS in the electoral process in Parungkuda District offers substantial benefits. It should be further developed to improve the effectiveness of the election process and encourage greater public participation.

Alpha testing is a form of user acceptance testing conducted on a limited scale. It is performed within a restricted internal environment. In alpha testing, the internal development team tests the product or application [15]. This testing aims to identify any basic bugs or defects in the product. The product's basic functionality is ensured through alpha testing [16]. The results of alpha testing can be found in Table 3.

Table 3. Alpha Testing Results

No.	Testing	Figure	Explanation	Result
1	Users Accessing the Application Website		The home page interface functions appropriately and provides a seamless user experience.	*Success*
2	Users access the route for the polling station location.		The route search interface functions appropriately and provides the expected results.	*Success*
3	Users access the election polling station location.		The election polling station location interface functions appropriately and meets the expected requirements.	*Success*
4	Users zoom in and zoom out the map.		The zoom-in and zoom-out icons function smoothly and perform their intended functions accurately.	*Success*
5	Users click on all the location icons on the map.		All the location icons on the map respond appropriately, and the application accurately displays the associated polling station details.	*Success*

No.	Testing	Figure	Explanation	Result
6	Users access the search for polling station location feature.		The coordinate search interface functions appropriately.	*Success*
7	Users log in as a member.		The system provides an excellent response to the member's username and password.	*Success*
8	Users cast their votes.		The system responds and accepts the user's voting data.	*Success*
9	Users access the voting results page.		The voting results page functions properly and displays the voting results accurately.	*Success*
10	Users log in as an admin.		The system provides an excellent response to the admin's username and password.	*Success*

4.   Conclusion

This research succeeded in developing a Geographic Information System (GIS) for mapping. TPS locations in Parungkuda District have provided significant benefits in terms of accessibility, efficiency, accuracy, and reliability of information. GIS makes it easier for the public to access TPS information, increases the efficiency of holding elections, provides accurate and up-to-date data, and allows access via electronic devices. Recommendations for future development include periodic data maintenance, integration with other technologies, and user empowerment through feedback. Therefore, this study emphasizes the importance of using GIS to map the location of polling stations in Parungkuda Regency to increase the effectiveness and transparency of the electoral process.

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