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Development and Analysis of GIS Regional Political Profiles in West Java Utilizing the Spatial Overlay Join Method

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ABSTRACT (10 PT)

This research aims to build a Geographic Information System (GIS) of Political Region Profiles in West Java using the Spatial Overlay Join method. The study addresses the political complexity in Indonesia, particularly in West Java, which serves as a significant political base. The success of political campaigns requires a profound understanding of voter preferences, demographic dynamics, and local issues. Limited access to accurate location data poses a serious obstacle to the effective design of campaign strategies. This research responds to these challenges by designing a GIS that integrates political and spatial data. The research focuses on West Java, where regional diversity poses unique challenges. Through the Overlay Spatial Join method, the research aims to provide in-depth insights into political region profiles, serving as a foundation for intelligent political campaign strategies. The benefits of the research include an understanding of regional characteristics, performance comparisons of political parties, and an in-depth analysis of campaign resource efficiency. The system integrates data from various sources, provides spatial visualization, and enables the analysis of regional profiles for the identification of deep political information. The research's contribution is not only academic but also practical in enhancing the effectiveness of democracy and general elections in West Java.

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1. INTRODUCTION

Indonesia, a democratic nation, faces various complex challenges in governing its political system. In this context, general elections play a crucial role as the foundation for the manifestation of the people's will in determining their political representatives. The 2024 General Election in Indonesia stands as the world's largest election, with over 200 million citizens exercising their voting rights in a single day to elect the president, vice president, as well as legislative members both at the central and regional levels [1]. West Java Province, as one of Indonesia's significant political bases, possesses distinctive characteristics with high population density and remarkable socio-cultural diversity. The General Election Commission (KPU) has officially announced the Permanent Voter List (DPT) for the 2024 General Election, with West Java Province having the highest domestic DPT with a total of 35.71 million voters [2]. This renders the province a crucial focus for political actors striving to secure public support through political campaigns.

In conducting political campaigns, effective strategies are essential; however, access to location data often poses a significant obstacle. Political parties and legislative candidates frequently encounter difficulties in devising effective strategies due to a lack of in-depth understanding of voter preferences, demographic dynamics, and local issues in each area [3]. Elections serve as the backbone of every democratic nation. Traditional campaign methods have become less effective in recent times. Currently, a targeted approach

utilizing demographic, socioeconomic, and geographic data, such as in Geographic Information Systems (GIS), is needed to determine effective campaign locations [4]–[6]. In addressing this challenge, this research aims to develop a Geographic Information System (GIS) integrating political data with spatial data to analyze regional profiles politically, particularly in West Java Province.

A Geographic Information System (GIS) is a computer-based system that enables algorithms to function in identifying an area on the Earth's surface. GIS provides both spatial and non-spatial data, including vector data, offering information about a position's existence [7]. Fundamentally, the term Geographic Information System (GIS) comprises three main elements: system, information, and geography [8]. Spatial data refers to data related to an object on the Earth's surface. Spatial databases entail structured data storage within a database system [9].

According to [10], GIS can operate with the following components:

1) Users who operate the system, including operators, analysts, programmers, database administrators, or stakeholders.
2) Applications are procedures used to process data into information, such as summation, classification, rotation, geometric correction, queries, overlays, buffer operations, table joins, etc.
3) Data used in GIS can be graphical and attribute data.

Geographic Information System (GIS) data is a crucial system development component. Data collection can be obtained from various sources, such as field surveys or interviews with informants. Three types of data instruments can be processed into a Geographic Information System: vector data, raster data, and attribute/tabular data [10].

1) A vector data model is capable of displaying, locating, and storing spatial data using points, lines or curves, and polygons along with their attributes [11]. Lines can be used to indicate a travel route or delineate the boundaries of an area. Polygons can be used to depict a lake or a country on a world map.
2) Raster data (also known as grid cells) is data generated from remote sensing systems. In raster data, geographic objects are represented as a grid cell structure called pixels (Picture Element). In raster data, resolution depends on the size of its pixels [12].
3) Attribute or tabular data is data in the form of text or numbers corresponding to the characteristics of objects and is both quantitative and qualitative [13].

Several previous studies have successfully applied GIS for political purposes:

This Android-based GIS application allows users to easily locate the placement of billboards managed by CV. Tunggal Abadi. Utilizing the Best First Search algorithm, this application facilitates search, provides relevant information, and offers an intuitive search menu to consumers [14].

The GIS mapping of the 2020 Semarang City Mayor and Vice Mayor election results is a web-based platform designed to present voting data more engagingly and understandably. Using Quantum GIS software, this system processes previously manually processed information data, presenting static features sorted by mapped regions [15].

Using ArcView 3.3, a Geographic Information System was developed to map the 2009 legislative election results in Semarang's electoral districts. The expectation is that the utilization of this GIS can provide clear visualization regarding the political landscape or political map of Semarang City, which will be crucial for the 2013 Regional Head Elections (Pilkada) and the 2014 General Elections (Pemilu). The presented information is expected to be beneficial for the general public, political party members involved in elections, and the KPU as the election organizer [16].

The researcher has not found in Indonesia previous research focusing on the application of Geographic Information Systems (GIS) to analyze effective campaign locations for legislative candidates and parties based on demographic, political, and other spatial data related to elections using the spatial overlay join method integrated to obtain insights into effective locations for political campaigns.

2. METHOD

The data collection techniques employed in this research are as follows:

1) Observation: Observation is a data collection technique that has specific characteristics compared to other techniques [17]. In this study, observation is necessary to obtain information about the electoral conditions in West Java.

2) Literature Review: Literature review involves a series of activities related to the method of collecting bibliographic data, reading and taking notes, as well as managing research materials [18].
3) Web Scraping & Public Repository: Web scraping is the extraction of a semi-structured document from the internet [19], as well as retrieving public data from websites, forums, institutions, or other open sources (public repositories). Data collection involves gathering large datasets from open sources. The following are the main data and sources collected for this research:

Table 1 Data Sources

Data	Data Source
Village Administrative Boundaries	Ministry of Home Affairs of the Republic of Indonesia
Population Data	Directorate General of Population and Civil Registration, Ministry of Home Affairs of the Republic of Indonesia
Point of Interest Education	Ministry of Education, Culture, Research and Technology of the Republic of Indonesia
Point of Interest Health	Ministry of Health of the Republic of Indonesia
Point of Interest Worship	Ministry of Religion of the Republic of Indonesia
List of Party Participants and Legislative Candidates	General Elections Commission of Indonesia

Spatial analysis is a collection of techniques used in processing GIS (Geographic Information System) data [20]. The Spatial Overlay Join method is a spatial analysis technique within Geographic Information Systems (GIS) used to combine and manipulate spatial data from two or more different datasets. The overlay function generates new spatial data from a minimum of two input spatial data sets [21]. The following are the techniques within the Spatial Overlay Join method:

1) Identification of Data to be Merged: Select the geographic datasets to be merged. For instance, administrative village boundary data and population demographic data.
2) Selection of Overlay Type: Choose the overlay type that aligns with the analysis objectives. Several common overlay types involve operations such as intersect, union, Difference, and others.

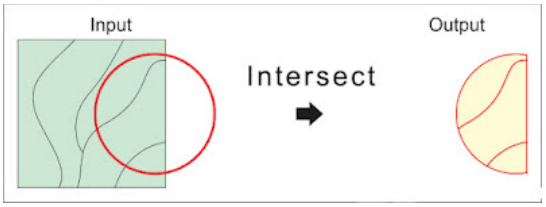

Figure 1. Intersect

The Intersect method is a way to clip a data layer according to the layer we have without deleting the attributes existing within the layer being clipped [22], as seen in Figure 1. The Intersect method is used to determine the overlap between input features. The overlapping portions of input features will be used to create new feature files, as illustrated in the above image.

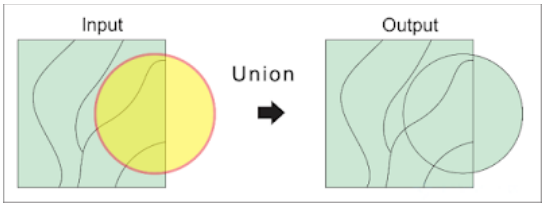

Figure 2. Union

The Union method is a process to create an overlay of two datasets. The output of this technique is the combination of both datasets, including their attributes and data [23], as seen in Figure 2. All features and their attribute data are utilized in the new feature, both in the overlapping and non-overlapping areas, as illustrated in the above image.

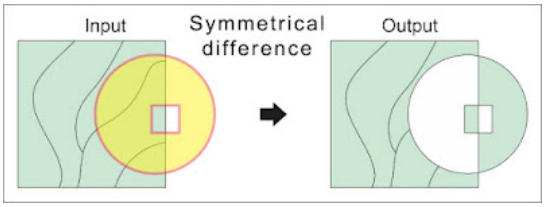

Figure 3. Symmetrical Difference

Symmetrical Difference is an overlay function used to assess values of abrasion and accretion [24], as seen in Figure 3. Symmetrical Difference is used to create a new feature class from two overlapping polygon features. Only the non-overlapping features will be used to create the new feature, as illustrated in the above image.

1) Execution of Spatial Overlay Join: Apply overlay operations to datasets using algorithms appropriate for the selected overlay type. In this case, overlay operations can be used to map village administrative boundary locations with demographic data or public facilities within them.
2) Attribute and Data Processing: After overlay operations are conducted, attributes from datasets can be integrated. For example, if overlaying administrative village boundaries with demographic data, demographic data for each village can be obtained.
3) Analysis and Interpretation of Results: Analyze the results of spatial overlay join to gain deeper insights into spatial relationships between objects in both datasets. For instance, evaluating population distribution within each administrative village area.

The System Development Life Cycle (SDLC) was one of the popular methods for developing information systems when information systems were first created [25]. One of its software development methods is the agile method, which the author used in this research. The software development methodology utilized in this research employs the agile method, known for its highly collaborative and flexible approach to software development.

The agile method is an incremental development approach that focuses on rapid development, releasing software incrementally, reducing process overhead, and producing high-quality code, the agile model is shown in Figure 4. It involves direct customer involvement throughout the development process [26]–[29]. This method is designed to enhance responsiveness to user and market needs, enabling developers to be more adaptive in addressing project/software development challenges. Unified Modeling Language (UML) is used as a modeling tool for system design processes, while Figma is utilized to design the user interface system.

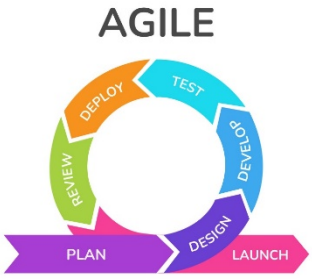

Figure 4. Agile Model Development Method

The following are the stages of Agile Model Development:

1) Plan: The planning stage marks the beginning of the software development process, where the team identifies project goals, defines requirements, and plans strategies to achieve them.
2) Design: Subsequently, in the design stage, the team focuses on designing the software architecture and detailing the features to be developed. Design includes data modeling, user interfaces, and program structures to be built.
3) Develop: The development process begins with implementing the design into actual code. The team works in sprints to produce functional pieces of software that can be tested.
4) Test: The testing stage involves testing the software to ensure that all features function properly and meet the specified requirements. It includes functionality, performance, security, and safety testing, both automated and manual, to ensure software quality.
5) Deploy: Once the software passes all tests, it is deployed or implemented into the production environment. This process involves installing the software on appropriate servers or infrastructure.

6) Review: After implementation, the team conducts a review of the development outcomes to evaluate the performance, quality, and compliance of the software with user needs and expectations. Feedback from this review is used for further improvement and development.
7) Launch: The final stage is the launch of the software to end-users or the market. It involves promotion, user training, and technical support to ensure successful adoption of the new software, as well as ongoing monitoring and updates as needed.

Educational institutions are full of processes, and some of these might benefit from a more agile, adaptive, change-embracing approach. Agile processes are essentially iterative cycles of creation and reflection, where budgets and timescales are fixed, and quality is given [28], [29].

3. RESULTS AND DISCUSSION

The Geographic Information System (GIS) for analyzing the political profile of West Java Province has been developed using the Overlay Spatial Join method by integrating political data with spatial data. The actor's interaction with the system is depicted with a use case diagram as seen in Figure 5:

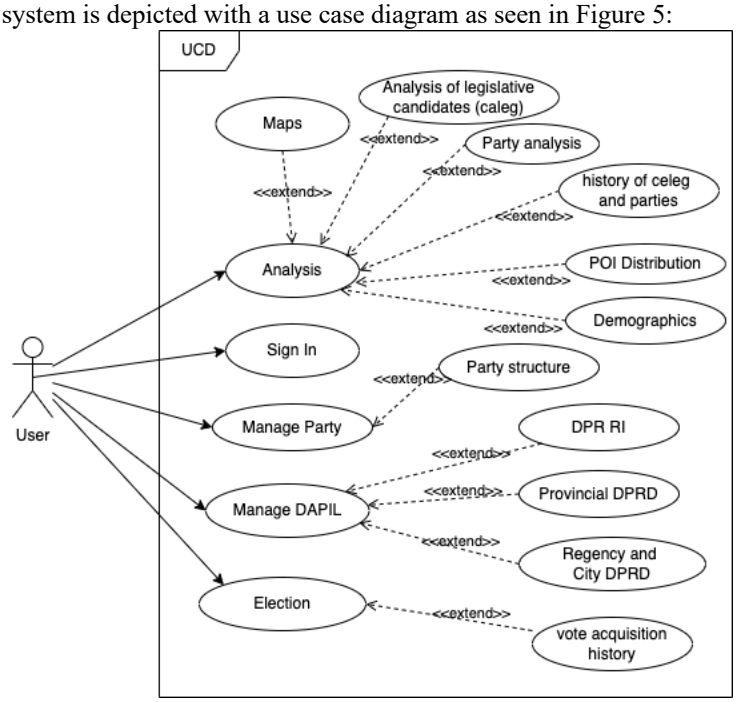

Figure 5. Use Case Diagram

Users need to sign in to the system to access the Analysis menu, Party menu, Electoral District (Dapil) menu, and the 2019 Election menu. In the Analysis menu, users will be provided with a map view that allows them to analyze the regions with a dropdown selection. In the Party menu, information about the parties participating in the election will be available. The Dapil menu will display the electoral districts for the National Parliament (DPR RI), Provincial Parliament (DPRD Provinsi), and District/City Parliament (DPRD Kabupaten & Kota). Finally, in the 2019 Election menu, users can view historical data on the results of the 2019 elections.

The activities of the system being built can be seen in Figure 6. To conduct analysis, users are facilitated in the Analysis menu by selecting the 'Legislative Election (Pileg)' type, and then choosing a location from the dropdown options. Afterward, users can view the analysis results of the legislative election type for the selected location in the form of a map, including candidate participation, party participation, historical participation of candidates and parties in the 2019 elections, distribution of points of interest, and demographic data.

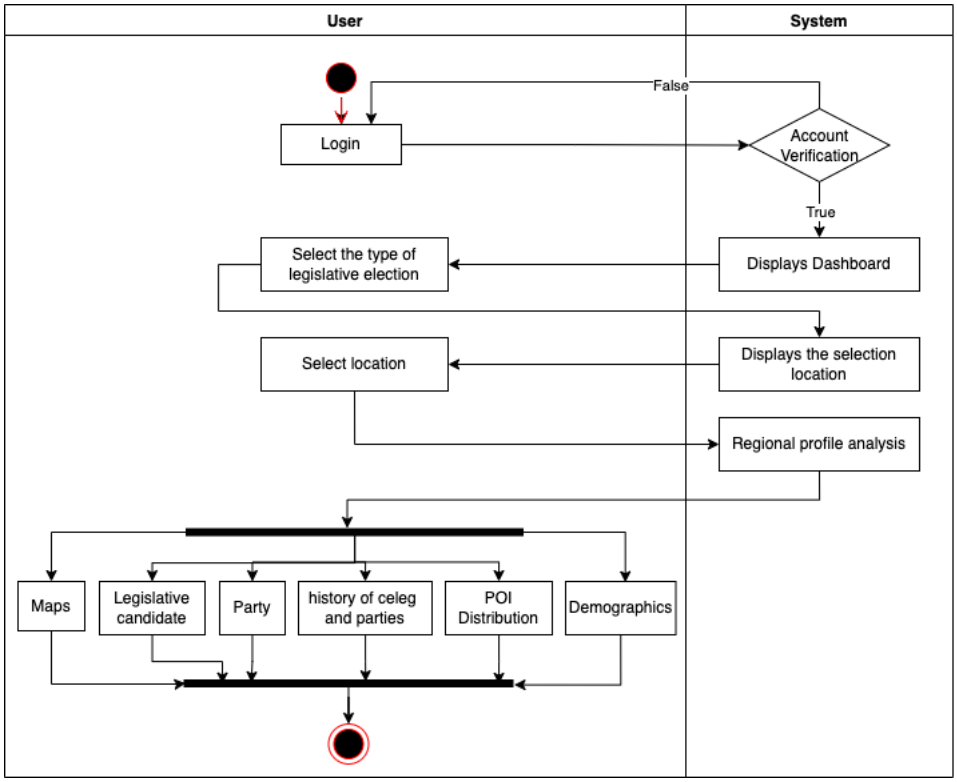

Figure 6. Activity Diagram

The system is designed to analyze the political profile of the regions in West Java using the overlay spatial join method. With this system in place, several benefits can be achieved, including:

1) Integration of data from various sources (such as village administrative boundaries, population data, political candidate participation data, and others) allows for a comprehensive understanding of the political profile of the regions.
2) This tool provides spatial visualization, supporting users to comprehend spatial data patterns and relationships.
3) By conducting regional profile analysis, users can identify in-depth political information that requires special attention based on current and previous election data. This can assist political parties in designing more targeted and effective campaign strategies.

The following is the display of results on the system that has been created:

1) Sign-in Page

Figure 7. Sign-In Page

Users can access the system after entering the correct email and password on the sign in page as shown in figure 7.

2) Analysis Page

The analysis page like figure 8 is where users can select their preferred electoral district (DAPIL) and after selection (apply), information about that electoral district will appear.

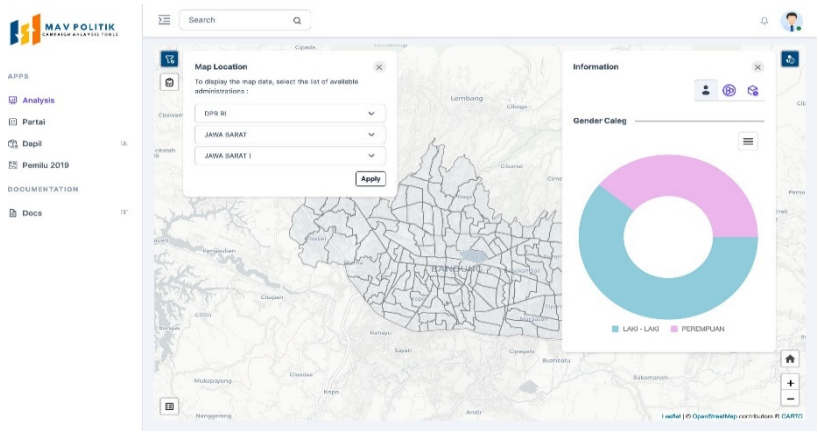

Figure 8. Analysis Page (1)

Analysis of candidate distribution from all participating parties in the current election in the selected electoral district, as seen in figure 9.

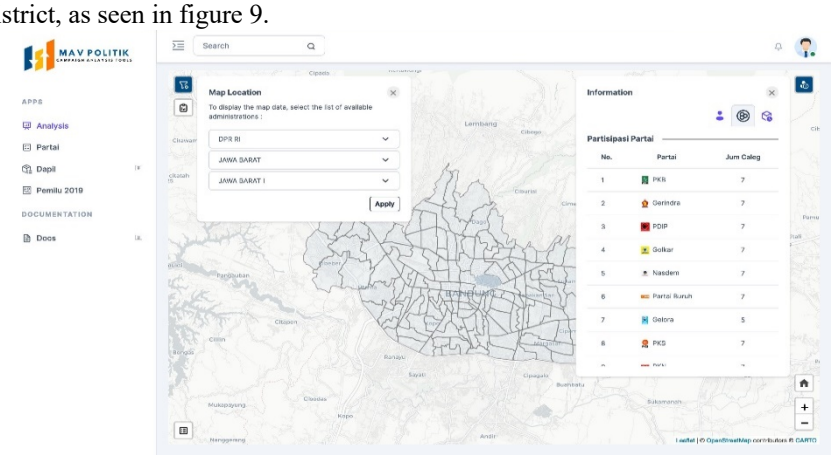

Figure 9. Analysis Page (3)

Figur 10 is an analysis of Party Participation and the number of registered candidates in the current election in the selected electoral district.

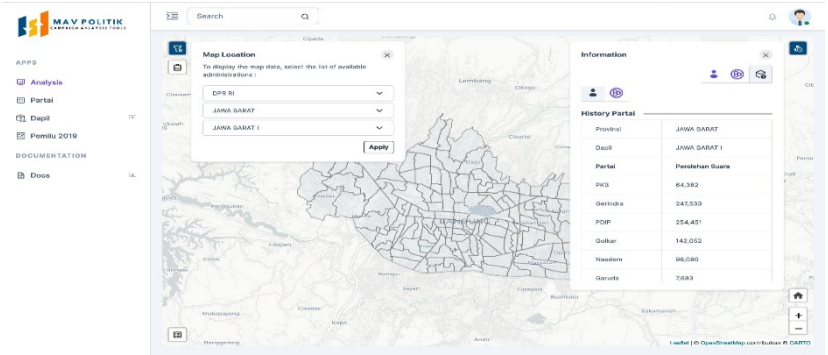

Figure 10. Analysis Page (4)

Analysis of the distribution of population by age in the selected electoral district can be seen in the figure 11.

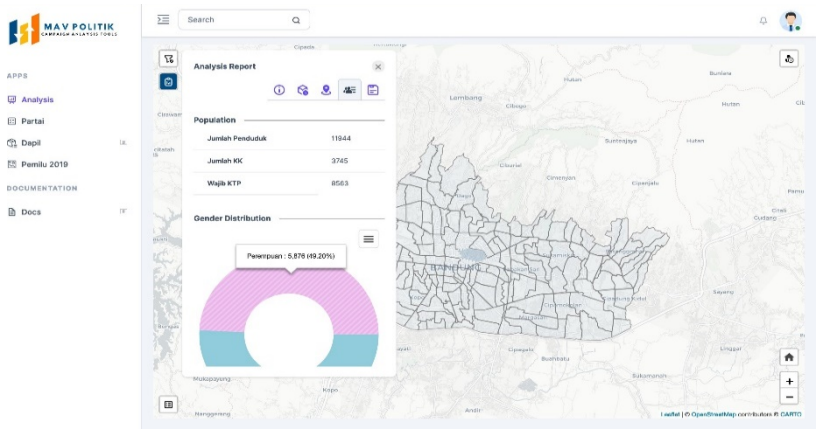

Figure 11. Analysis Page (9)

Analysis of the population count and the number of registered voters who are eligible to vote in the current election, as well as gender distribution on charts in the selected electoral district, can be seen in the figure 12.

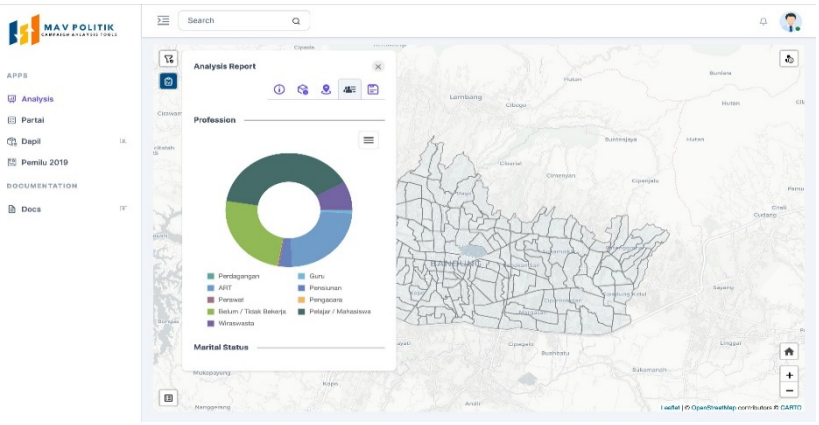

Figure 12. Analysis Page (10)

3) Political Party Page

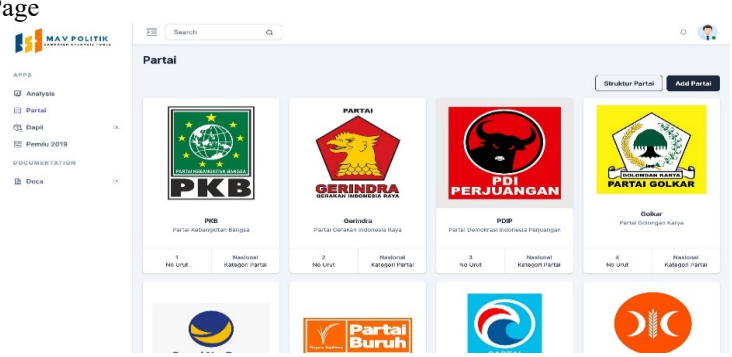

Figure 13 Political Party Page

4. CONCLUSION

Based on the research findings, it can be concluded that the development of a Geographic Information System (GIS) integrating political data with spatial data can contribute significantly to enhancing a deep understanding of the political profile of the West Java Province. Using the Overlay Spatial Join method, the author successfully analyzed profound insights into the characteristics of political regions, including population density, demographic profiles, locations of public facilities, and voter preferences. The results of this research can provide practical benefits for political actors, such as political parties and legislative candidates, in planning more effective political campaign strategies. With a more accurate understanding of voter preferences and regional dynamics, political parties and legislative candidates can allocate resources more efficiently and choose appropriate campaign locations based on data analysis. Additionally, GIS analysis

of regional profiles can also serve as an objective performance evaluation tool for political parties, assisting in refining strategies for the elections.

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