Web-Based Village CCTV Information System to Support Smart City in Yogyakarta

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Abstract

Smart cities and safe cities were modern city concepts based on information technology that had been implemented in many major cities in the world. The smart city includes information and communication technology-based city development with good infrastructure integration. One example of smart city implementation was the installation of Village CCTV in Yogyakarta City. For optimal CCTV operation, an integration system between various parties was required. In that context, the Website was used as a management tool that combined various aspects. This Website was developed using PHP MySQL as a database, JavaScript and PHP programming languages for logic and functionality, HTML as a website structure, and display design using Bootstrap. This research used qualitative methods and produced a Village CCTV Website, which had the main objective of providing information about Village CCTV efficiently and effectively in managing CCTV management. Users could quickly and accurately access information related to CCTV Village. Thus, this Website became an important tool in improving security, comfort, and surveillance in the village.

Keywords— Information System, Smart City, Web-based, GIS, Village Security

1. INTRODUCTION

Smart City, as one of the latest policy innovations by the government, was driven by Indonesia's high urbanization rate from rural to urban areas each year. Therefore, the advancement of information and communication technology is crucial for the progress of major cities [1], including Yogyakarta, as a means of implementing a smart city approach to address issues and serve its citizens [2]. Appropriate and relevant technology can be utilized as a solution to the challenges faced by the community [3]–[7]. Yogyakarta, known for its role in education, trade, tourism, services, and culture, has embraced a vision of becoming a "City with a Comforting Heart." One of the key factors in achieving comfort is ensuring the safety of its residents. Technology has played a pivotal role in addressing urban issues, particularly in the realm of security. One effective technology in the field of security that has expedited the transformation process to ensure the safety of residents is the installation of CCTV cameras [8][9]. The security approach involving CCTV procurement aims to provide quick responses and furnish video data as evidence, thereby enhancing situational awareness and comfort for both residents and tourists visiting Yogyakarta.

There are several related studies to support this research. Some of the researchers included [10] successfully developed an information system for village boundaries that provided ease of access and understanding of boundary information for various parties. Other research produced a web-based GIS application for the distribution of health facilities in Kudus Regency [11]. Other applications developed using a web structure with HTML, programming languages (JavaScript and PHP), MySQL as the database creator, and some online base maps such as Mapbox, Google

Maps, Leaflet, etc [9], [12], [13]. A literature review of web-based GIS was carried out to examine needs in system development based on its objectives [11], [12], [21]–[27], [13]–[20]. The other research involved in the system development is the analysis of system requirements [28]–[33].

The studies mentioned previously have described the use of different methods and applications to build management information systems with their respective objectives. These then became a reference for this research to build a CCTV management system at the village level which is currently not available in the city of Yogyakarta. To maximize the benefits of the CCTV system in Yogyakarta, there is a need for integration among various stakeholders in its management. To meet this requirement, the development of a management website that offers rapid and accurate information has been undertaken. A concrete example of web usage in support of the smart city concept is the implementation of a web-based Village CCTV Information System in Yogyakarta. Through the use of a website, Yogyakarta can enhance efficiency and effectiveness in CCTV management. Digital presentation of information via the website facilitates structured viewing, management, and maintenance of CCTV data. Consequently, this website aids Yogyakarta in realizing the smart city concept by optimizing the use of information technology for CCTV management and enhancing security services for the city's residents.

2. RESEARCH METHODS

The scope of elements in this system development consists of identifying data requirements and identifying system users. The identification of data requirements in creating the Village CCTV website involves identifying the types of data needed to build the system. Meanwhile, the identification of user requirements for the Village CCTV website involves understanding the needs, expectations, and objectives of users in using the system.

The data collected is obtained through interviews with village officials and BAPPEDA, and it includes CCTV camera coordinates, camera viewing angles, installation status, installation dates, camera types, and CCTV photos. Additionally, there are administrative boundary data for the villages in GeoJSON format and the final report on the CCTV infrastructure study from Yogyakarta City Regional Planning and Development Agency in 2022.

After the data had been successfully collected, the next step involved designing the system by creating use cases, activity diagrams, and class diagrams. Based on Figure 1, the use case diagram could describe the typical interaction between the admin and users. Interactions in the system would occur when users accessed the system, and these interactions began with users issuing commands to the system through various available menus. These commands were then conveyed by the system to the server for processing. The processing by the server resulted in a response, which was then displayed by the server through the user interface.

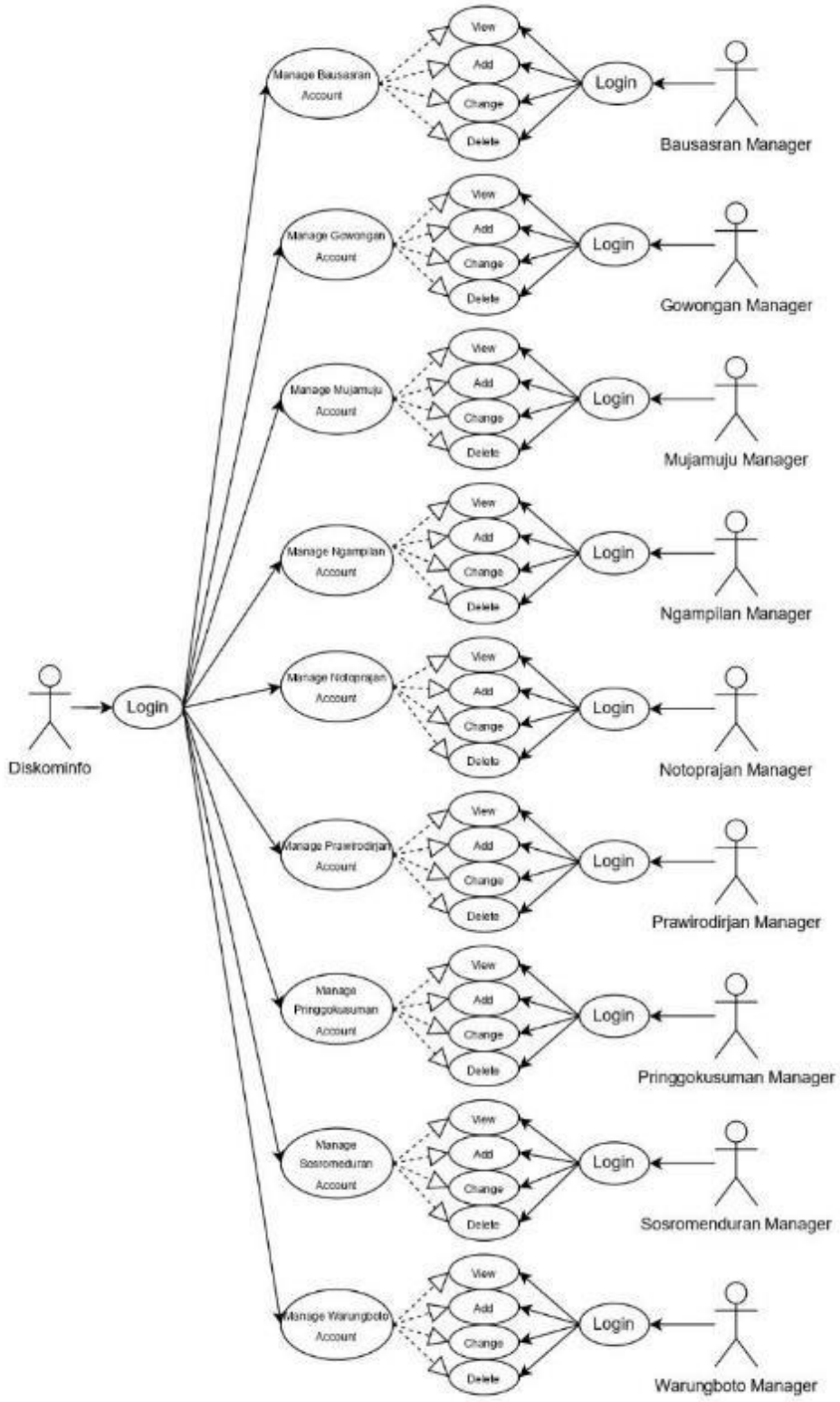

Figure 1. Use Case Diagram

The Class diagram was one of the types of diagrams in the Unified Modeling Language (UML) used to depict the static structure of a system or application [34]. The Class diagram depicted the classes within the system, the relationships between those classes, the attributes

owned by the classes, and the associated methods. The Class diagram provided a higher-level understanding of the system's structure and its components. In Figure 2, it describes the relationships between the components of the class diagram. There are three classes User, CCTV, and Setting. The User class has attributes such as id, name_user, email, password, and photo. The CCTV class has attributes including ID, name, direction, status, date, type, coordinates, photo, address, and sub-district. Meanwhile, the Setting class has attributes like id, website_name, region_coordinates, and zoom_view. These three classes have relationships with each other.

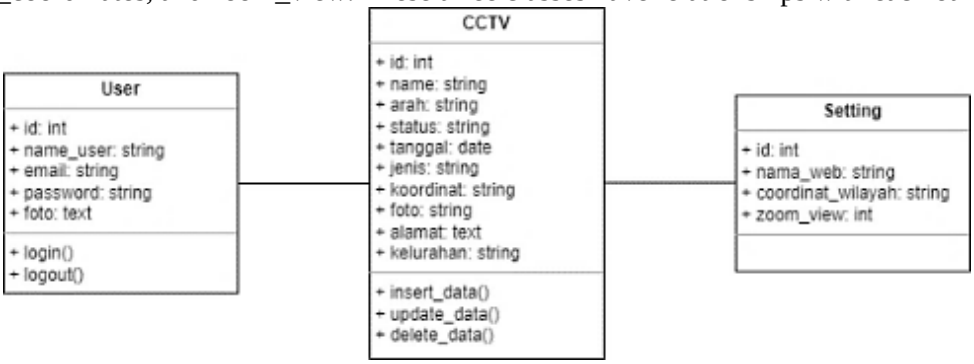

Figure 2. Class Diagram of the system

Some activity diagrams were also conducted for this system activity such as login (Figure 3), adding a user account (Figure 4), adding CCTV data (Figure 5), viewing CCTV detail (Figure 6), etc.

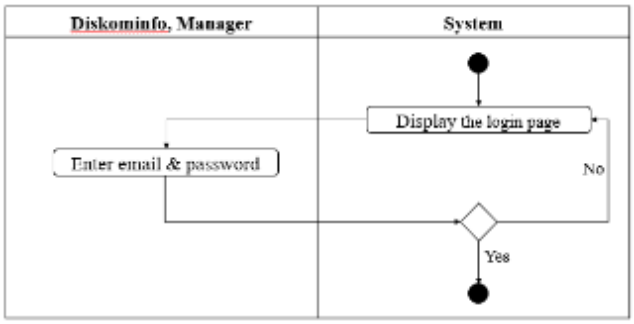

Figure 3. Activity diagram for login

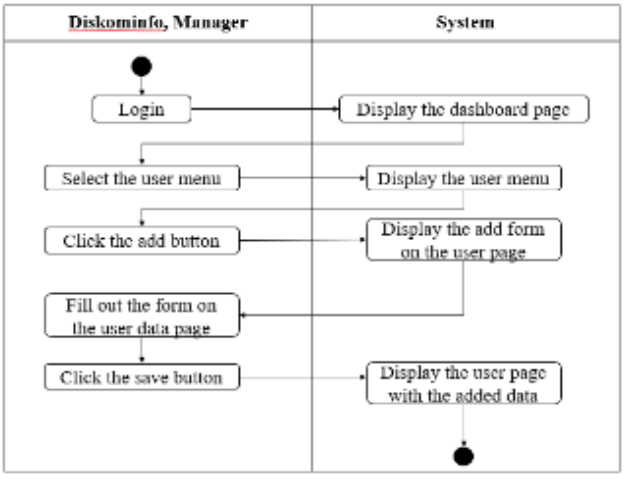

Figure 4. Activity diagram for adding a user account

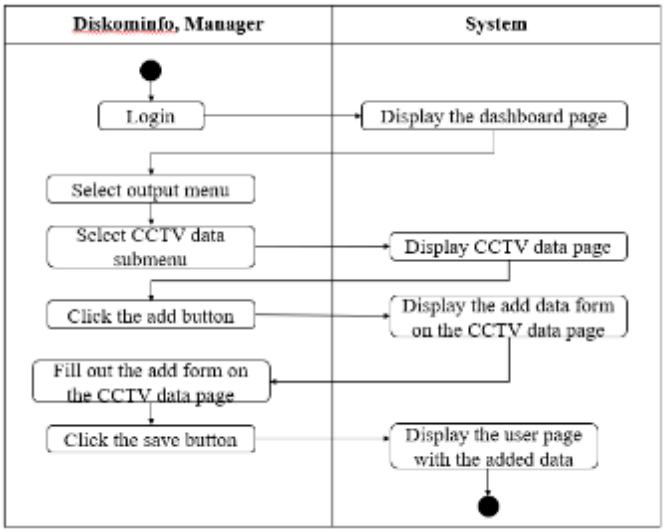

Figure 5. Activity diagram for adding new CCTV data

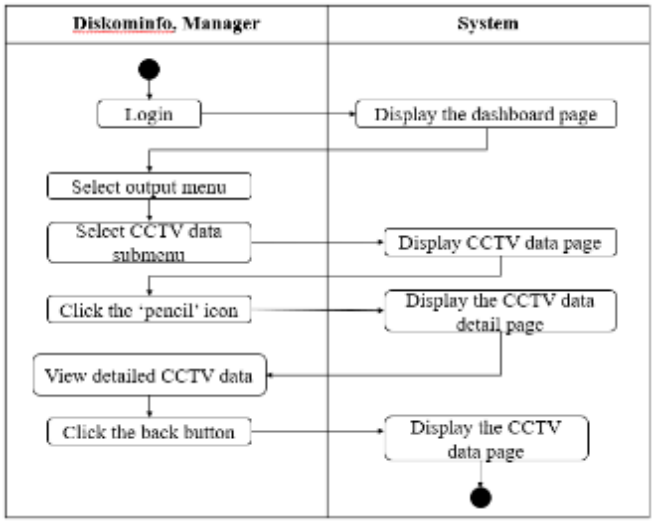

Figure 6. Activity diagram for viewing detailed CCTV

The next step is website development. Website development consists of three stages: creating the GeoJSON file for sub-district boundaries, designing the user interface, and coding. Creating the GeoJSON file for sub-district boundaries is the process of generating a file containing geometric information and geographic attributes that depict the boundaries of a sub-district. In the user interface design phase, we describe the design of the interface for the web-based Village CCTV management system (Figure 7). Coding, in software development, refers to the process of writing instructions or commands using a specific programming language to create computer programs. In the context of website development, JavaScript is used to handle interactivity on the website, HTML is used to create the structure of web pages, and Bootstrap is used to design the appearance and style of web pages. HTML and Bootstrap are used to create page layouts, buttons, and other visual elements within the website context.

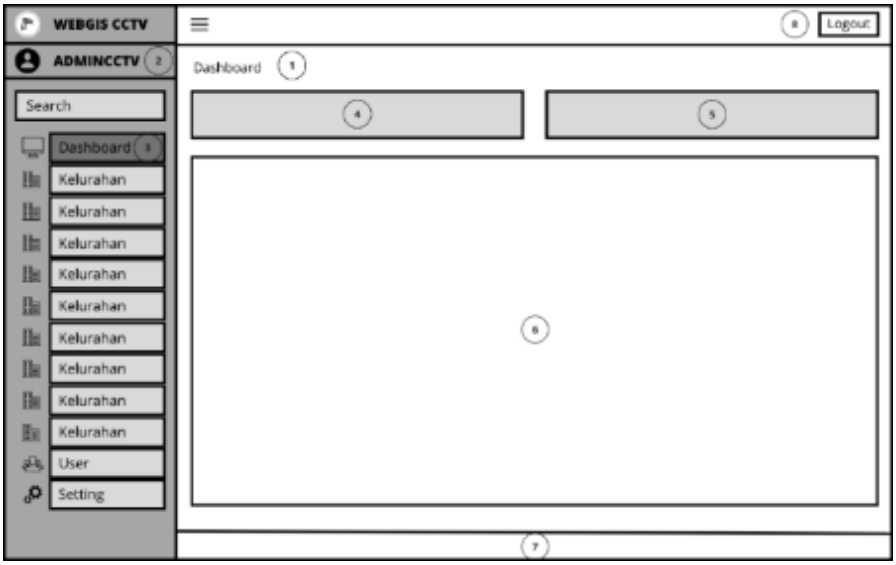

Figure 7. User interface design of administrator dashboard

The testing phase encompasses system testing and user testing. System testing is conducted to assess the extent to which the information system can meet the requirements and how easily and efficiently the system can be used. User testing, on the other hand, is carried out through interviews, observations, and questionnaire surveys (Table 1) to assess the user's perspective. The results of user verification testing will provide insights into how well the system meets user expectations and needs and help identify areas that may need improvement or correction.

Table 1. Lists of questions for respondents

No	Question	Answer choices
1.	The WebGIS CCTV system is easy to use	Likert scale: 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree
2.	WebGIS CCTV provides information that perfectly suits your needs.	
3.	WebGIS CCTV provides an attractive appearance and features.	
4.	CCTV WebGIS makes it easy to manage CCTV data	
5.	The system for adding, editing, and deleting CCTV data is very easy to understand	
6.	The process of adding, editing, and deleting CCTV data runs quickly.	
7.	The layout and structure of information on the website is easy to understand	
8.	The map feature provided is very informative.	
9.	WebGIS's response to user actions is very fast.	
10.	I didn't find a menu that didn't work according to its function.	
11.	Is there any additional input, suggestions, or feedback you would like to provide regarding WebGIS?	*Respondents fill in*

3. RESULT AND DISCUSSION

3.1 System Requirements Analysis

The website had to contain information such as CCTV names, CCTV locations, viewing directions, installation statuses, installation dates, CCTV camera types, and CCTV photos. Additionally, there needed to be the capability on the website to add, edit, and delete CCTV data. This feature allowed authorized administrators or users to perform these actions easily. For security reasons, there were two actors in this context: administrators and users. Administrators had access rights to enter the administrator page by first logging in and managing all the data on the administrator page. On the other hand, users (residents) were not allowed to access the administrator page. Users (residents) also had to log in according to their respective sub-districts. Users were only granted access to view CCTV information and could add, edit, and delete CCTV data for their own sub-district.

3.2 Information System Design

The information system development resulted in the creation of a database named "db-gis-cctv-ci4." This database was constructed using PhpMyAdmin with the MySQL feature enabled in XAMPP. Referring to Figures 8 and 9, there were three tables in the database design of the web-based Village CCTV management system. These tables were the CCTV table (tbl_cctv), the setting table (tbl_setting), and the user table (tbl_user).

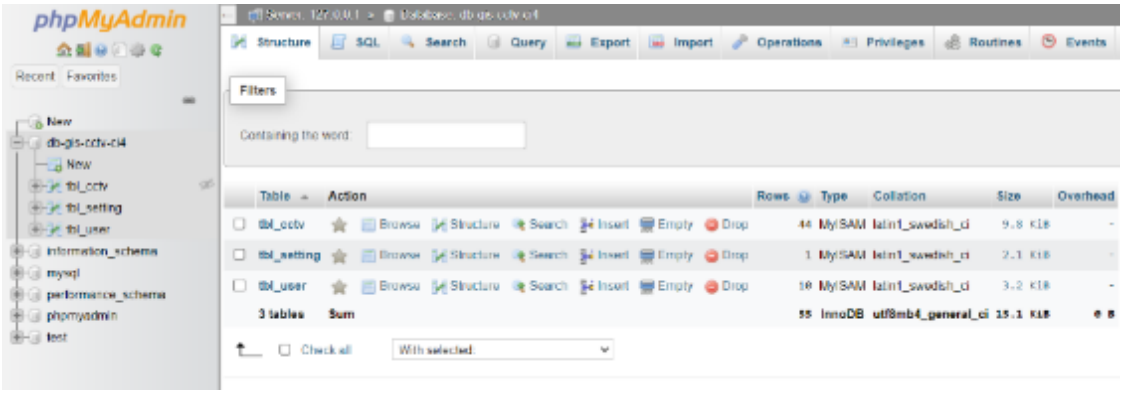

Figure 8. The Database of Village CCTV Management Website

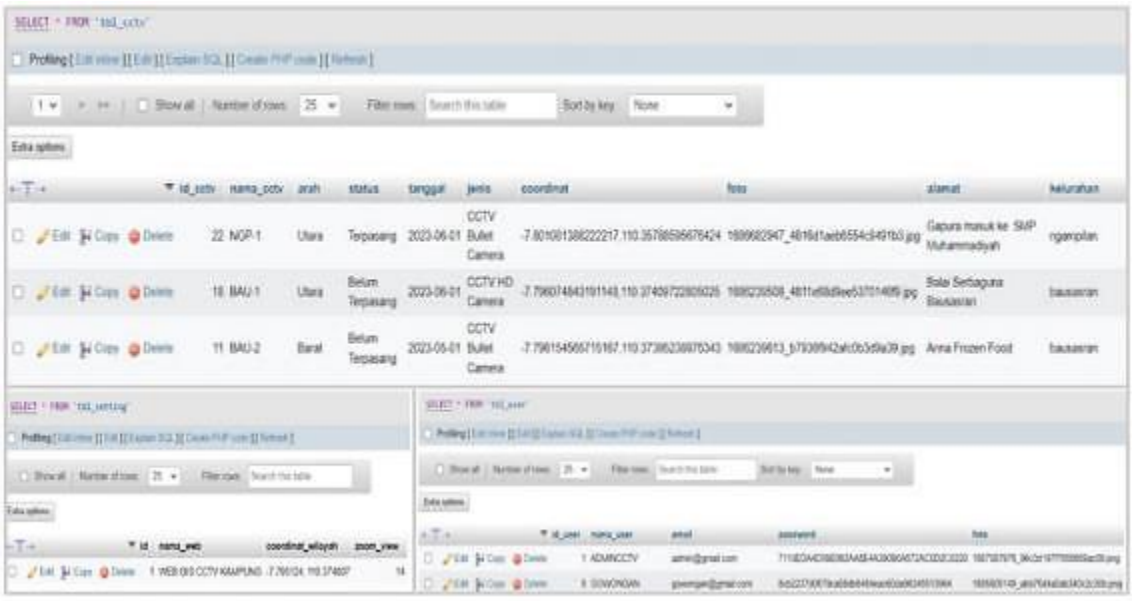

Figure 8. The structure for each table.

3.3 Web-Based System Development

After the website creation process was completed, the result was a website that could be accessed via the Internet and was ready for use by users. The website had a design that met the predefined needs and objectives. The features implemented on the website also aligned with user requirements analysis and the specified specifications. The results of website development included various components, such as a responsive and appealing user interface, a clear and intuitive navigation structure, and layouts that made it easy for users to interact with the provided content and features.

The dashboard page served as the initial view after logging in (Figure 10). On this page, there was a map displaying the distribution of CCTV cameras in Yogyakarta City, divided by sub-district administrative boundaries. There were 9 sub-districts equipped with CCTV, marked by specific colors on the map. Clicking on a CCTV point would trigger a popup with information

about the CCTV's name, address, and CCTV camera type. Furthermore, there was information regarding the number of CCTV cameras in each sub-district and the number of users with access to the CCTV website.

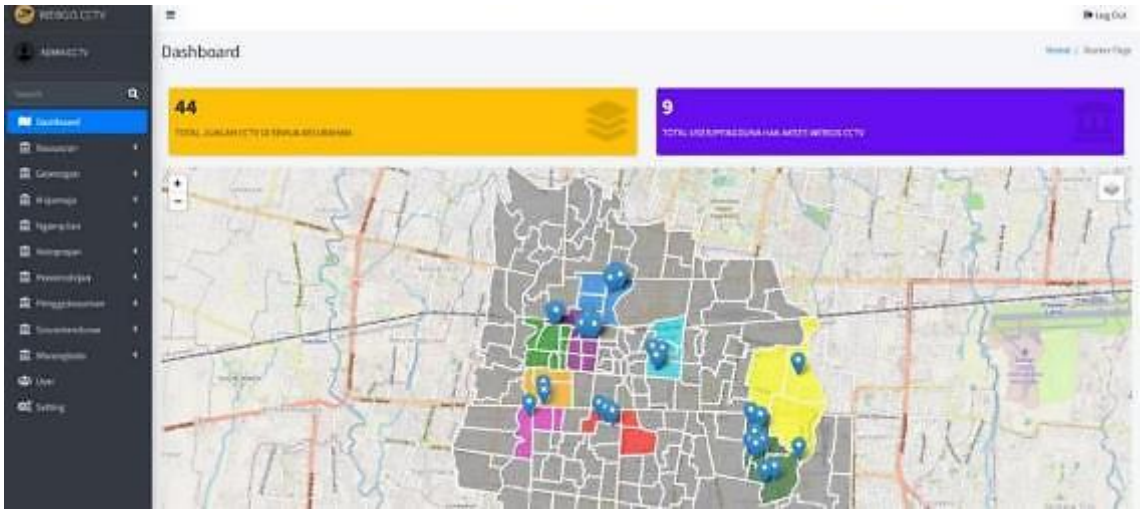

Figure 10. The Admin Dashboard Page

The CCTV Data CRUD page contained all information related to the management of CCTV in each village, including the CCTV name, viewing direction, installation status, installation date, CCTV camera type, address, CCTV photos, and action options (Figure 11). In the action section, there were three icons, each with its function. The eye icon was used to view detailed CCTV data, the pencil icon was used to edit or update CCTV data, and the trash icon was used to delete CCTV data. Additionally, there was an "Add Data" button located in the top right corner of the page. Furthermore, this page was equipped with a search button to assist users in finding CCTV data easily (Figure 12).

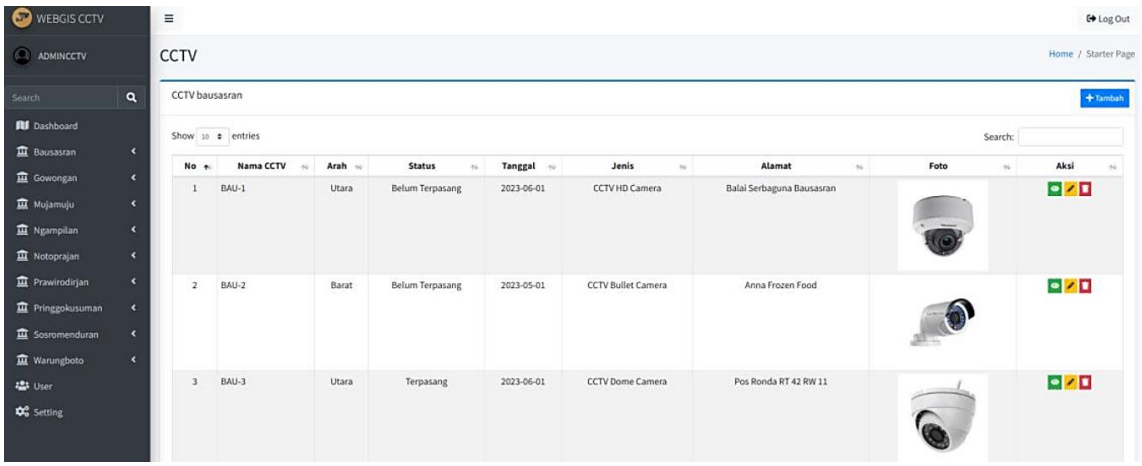

Figure 11. The Number of CCTV Cameras and Users with Access to The CCTV Website

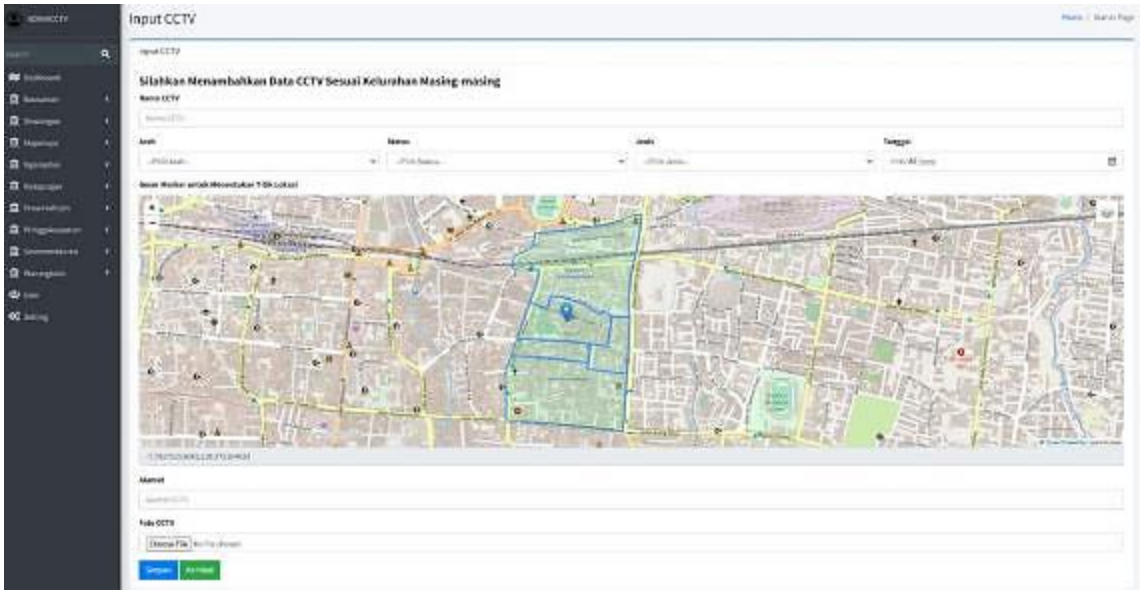

Figure 12. The CCTV Data CRUD Page

3.4 Testing Result

The testing of the web-based Village CCTV management information system was conducted using the Likert scale method. The testing involved 27 respondents who were asked to complete a questionnaire. The questionnaire consisted of 10 statements related to the functions and user satisfaction with the web-based Village CCTV management information system. In the questionnaire, respondents were asked to choose responses from options such as "Strongly Disagree," "Disagree," "Neutral," "Agree," to "Strongly Agree.".

Based on the test results, it can be concluded that the majority of the respondents, namely 85.2% strongly agreed while 14.8% agreed that the system is easy to use and there were no non-functional menus found in the web-based Village CCTV management information system (Figure 13). The positive response from the majority of the respondents indicates that the system successfully provided functional menus in the web-based Village CCTV management information system. When an information system obtains satisfactory results from users, this shows that the system has succeeded in meeting the desired goals. Users experienced that this system can provide significant benefits in improving CCTV security and management in the village. Thus, satisfactory results from this questionnaire provide confidence that the village CCTV management information system meets user expectations and is suitable for use as an effective tool in managing village CCTV.

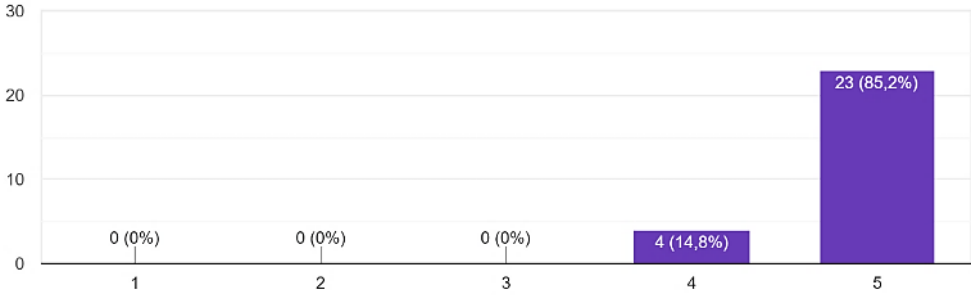

Figure 13. One of the results of the questionnaire related to the ease of use of the system

4. CONCLUSION

This research concluded that the design in the development of the web-based Village CCTV management information system was considered to meet user needs. The success of this information system can be seen in its usefulness and user satisfaction regarding the system. Users felt that the designed system met their needs in managing CCTV data effectively and efficiently. Users could easily access, add, edit, or delete CCTV data using the information system. Furthermore, with the web-based Village CCTV management information system, the management of CCTV became more integrated. The system provided a clear and organized framework for managing CCTV in the villages. Through the website, users can easily view the locations and information of CCTV cameras throughout the villages. This information was presented in an interactive map format, allowing users to quickly access and identify the locations of existing CCTV cameras. Therefore, this website-based information system can improve security services for village residents which of course supports the realization of a safe city as the implementation of a smart city in Yogyakarta.

This website allows CCTV data to be visualized in the form of an interactive map. The development of a website for CCTV management in the village has great potential to support the Smart City concept. The use of this technology provides an important contribution to the collection, analysis, and utilization of CCTV data to support intelligent decision-making, accelerate response to emergency events, and encourage active participation of residents in maintaining village security. With the Website, CCTV data spread throughout the village can be collected, categorized, and analyzed centrally. Through the use of the Website, information generated from CCTV can be integrated, analyzed, and utilized effectively to improve residents' security and quality of life in the context of a Smart City.

By mapping the location of CCTV cameras in the village, security officers can monitor the situation in real-time. By providing accessibility for the public to view security information through the Website, residents can report suspicious incidents, provide feedback, or participate in security campaigns. This strengthens the role of the community as additional "eyes and ears" in maintaining village security. By utilizing the potential of the Website for CCTV management in the village, Smart City can achieve more effective and efficient security goals. This monitoring can be done directly from the security operations center or through a mobile application, thus providing faster response capabilities to suspicious events or emergencies. Website development can also encourage active community participation in maintaining village security.

Further research can be focused on developing additional features that can improve the functionality of the information system, for example, adding live streaming for each CCTV, adding NVR cable lines, and adding more precise map coordinates. In addition, research can direct attention to security and privacy aspects in the development of this system.

5. ACKNOWLEDGMENTS

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