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Geographic Information System for Mapping Deployment Areas Dengue Fever in Umalulu District

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Abstract

Dengue fever is a disease caused by the dangue virus, causing serious health problems, especially in Umalulu sub-district, East Sumba Regency which has an area of 307.90 km2 and consists of 10 villages, each of which has an impact on dengue cases. This study aims to map the area of the spread of dengue fever in real time in Umalulu sub-district using a Geographic Information System (GIS), which is currently experiencing the problem of an increase in the number of dangue hemorrhagic fever cases and assistance that has not been targeted. The research method used is Waterfall, which follows the stages of planning, data collection, system analysis and design, implementation, and maintenance. Based on black box testing, this research succeeded in producing a web-based GIS that maps the dengue fever distribution areas in showing that the Lumbukore village is the area that has the highest number of cases with 12 and the Ngarukanoru village with the lowest area with 0 cases, with an average of many cases occurring in March and April of 2024 in Umalulu District, allowing users to analyze dengue disease distribution patterns provide recommendations for prevention and control measures for dengue disease more accurately and on target.

Keywords: *DBD, Waterfall, Realtime, Black Box, GIS*

1. Introduction

Dangue Hemorrhagic Fever (DHF) is a disease caused by the Dangue virus which is transmitted through the bite of the aedes aegypti and aedes albopictus mosquitoes. Infectious diseases, especially dengue fever, are very closely related to geographical and spatial aspects, because one of the causes of dengue fever cannot be separated from environmental factors, this allows environmental factors to be mapped. Umalulu District is one of the sub-districts in East Sumba district with an area of 307.90 km^2 with a population of 17,667 people and a number of villages consisting of 8 villages. In Umalulu sub-district there are several cases of dengue fever in various villages, case data collected from the East Sumba district health office and the Melolo health center show that the pattern of the spread of dengue disease has increased from the previous year, namely, in 2022 there were 14 cases of suspect cases, including 13 cases of dengue fever recovered and dengue fever 1 case recovered, Furthermore, in 2023 there will be a decrease in cases from 14 cases to 1 case of dengue, but in 2024 from January to April there has been an increase in suspected cases of Dangue fever as many as 47 cases and Dangue hemorrhagic fever has occurred 4 cases and 1 case of dengue fever among which died. The increase in the spread of dengue cases in Umululu District occurred due to several factors, namely, poor environmental factors, house density, lack of awareness of environmental cleanliness and also weak immunity so that it is easy to be attacked by dengue disease. In addition, the lack of socialization to the community in Umalulu sub-district to increase understanding of the dangers of dengue fever and the uneven provision of health assistance from the government, based on the results of interviews with dengue fever managers, the assistance provided is only obtained if the patient is treated at the nearest health center, and no assistance is distributed directly to the community so that there are dengue fever sufferers who carry out self-treatment and are not in accordance with the actual handling, and the health authorities do not pay attention to areas that are prone to Dangue fever so that the assistance distributed is not on target or not on target.

From the above problems, it can be concluded that technological advances can be used to prevent and control dengue fever, in this case a solution is obtained to implement a geographic information system for mapping the distribution area of Dangue hemorrhagic fever in Umalulu District. By utilizing this geographic information system (GIS) can help monitor with mapping, because through mapping it will be visually visible how dengue fever cases are distributed in the Umalulu sub-district area, so that high-risk areas and areas that need more attention can be identified. The geographic information system is implemented to provide convenience in storing data on cases of dengue fever or dengue fever in Umalulu sub-district so that it will make it easier to identify. With this system, it can accelerate and make it easier for medical personnel to provide assistance for the control of Dangue fever to Dangue hemorrhagic fever more accurately and on target to areas that are prone to being affected by Dangue hemorrhagic fever so as to reduce the number of cases and improve the health of the people of Umalulu sub-district as a whole.

2. Literature Review

2.1. Geographic Information System

A geographic information system is a computer-based information system that is used to provide information in digital form and conduct analysis of the earth's surface. This system functions to store, check, integrate, manipulate, analyze, and present data related to all aspects of space related to the condition of the earth [1]. The application of geographic information systems will help in investigating the spread of dengue fever cases and be used to monitor areas affected by dengue fever to overcome cases of dengue fever [2].

2.2. Dengue fever

Dangue dengue fever is one of the diseases caused by arbovirus. Arbovirus is a virus that is transmitted through insect bites arthropoda, Like mosquitoes, if mosquitoes suck humans who are in the virus, the virus will multiply in the mosquito's body during the incubation period. This disease can cause symptoms of high fever, headache, joint muscle pain, nausea, vomiting, rash, and bleeding, this disease can also develop into more severe dengue and is at risk of being life-threatening [3]. Medical decision-making can be supported by information systems in spatial form as advances in geographic information systems have allowed for more effective analysis of various aspects of the health system [4].

2.3. Unified Modeling Language (UML)

Unified Modeling Languange is a modeling language for systems or software that are typical or object-oriented. Modeling is actually about simplifying complex problems to make them easier to learn and understand. UML allows software development to better understand software systems and helps identify system design issues and errors before implementing the system [5].

2.4. Class Diagram

Class Diagram is a static structural model used to describe the structure of a system, consisting of classes and relationships between classes. The classes in this diagram include attributes and operations. In the class diagram, there are three important types of relationships, namely association, aggregation, and inheritance [6].

2.5. Activity Diagram

Activity Diagram used to describe the sequence of activities in a planned system. This diagram shows how each activity begins, possible decisions, and how the activity ends. In addition, activity charts can also show parallel processes that may occur during multiple executions [7].

2.6. Metode Waterfall

According to [8] method waterfall is the most commonly used method in the development stage. Method waterfall is the first SDLC approach applied in software development. Type waterfall It is often referred to as a sequential linear model or a classic cycle that starts from the initial planning stage to the maintenance stage at the end of system development. Each stage must be completed completely before proceeding to the next stage, and there is no possibility to Go Back or repeat to the previous stage.

2.7. Black Box

Black box testing is a testing method that focuses on observing execution results through test data and checking software functionality. The tester only observes the output produced without knowing or paying attention to the internal processes that occur. Like the black box analogy, the tester can only see the outside or appearance of the system (interface) and check if the functions are working properly, without learning the internal details of the process. In other words, the examiner only knows Input and output, without understanding the internal mechanisms that produce those outputs [9].

3. Research Methodology

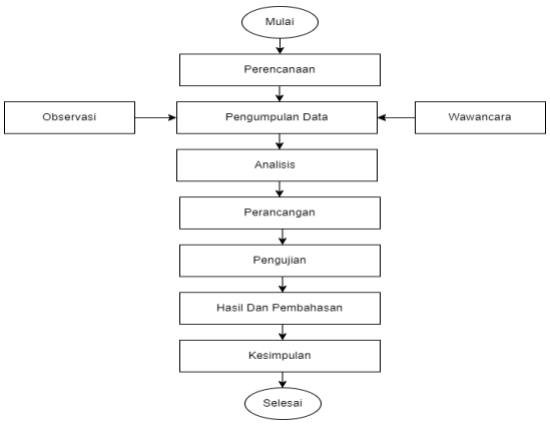

Fig. 1: Research Flow

Information:

1. Planning stage
   At this stage, planning was carried out related to the determination of case studies in Umalulu district.
2. Data collection stage
   At this stage, data collection is carried out in accordance with the needs of the geographic information system obtained through the observation process in Umalulu sub-district and also interviews with Umalulu sub-district officials, as well as medical personnel at the sub-district health center so as to obtain the necessary data and enter it into the geographic information system for mapping the dengue distribution area.
3. System analysis and design are carried out to understand the needs of users in the system being built. The website trial was carried out to assess the success of the website in processing and displaying the information needed by the community.
4. Planning stage
   At this stage, the system is designed in detail, including the development of the database structure, system architecture, and user interface.
5. Testing stage
   At this stage, an overall test is carried out on the system that has been designed to ensure its performance is in accordance with the set standards.
6. Results and Discussion
   At this stage, the implementation of the tested system is carried out including data migration and user training as well as conclusions.

4. Results and Discussion

4.1. Use Case

The image below illustrates the relationship between admin and user (visitor). In the system, there are two actors, namely admin and user. The Admin will log in and will be validated first by the system before being able to access the functions of the subsystem. Admins can manage dengue data in the system, namely they can input, edit, delete, and display dengue case data, and can display geographic information, namely mapping the distribution of dengue cases and logging out. Users or visitors to the system can view information on the dengue distribution map.

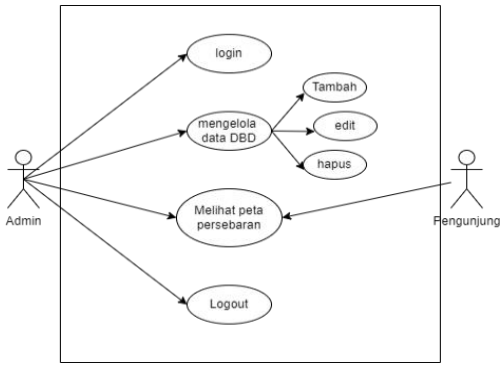

Fig. 2: Use Case Diagram

4.2. Activities Login

The image below explains the admin who performs the login process to the main admin page. The first thing to do is log in to the site first after that on the Login page, the admin can enter the username and password that will be validated first. If the username and password are correct, it will continue on the main admin page, but if it fails or the username and password are incorrect, the admin will refill the username and password.

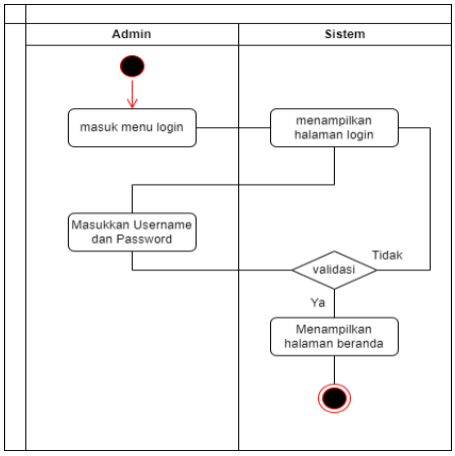

Fig. 3: Activity Login

4.3. Input Data Activities

The image below explains that the admin adds data or inputs dengue data, after the admin logs in, the system will display the main page containing the menu of dengue case data, the admin can choose to add data and the system will display a form for the admin to be able to enter the case data after that the admin can save it, then it will be checked first, if the data entered is complete, the data storage will continue, However, if the data entered is incomplete, the admin will fill it in again.

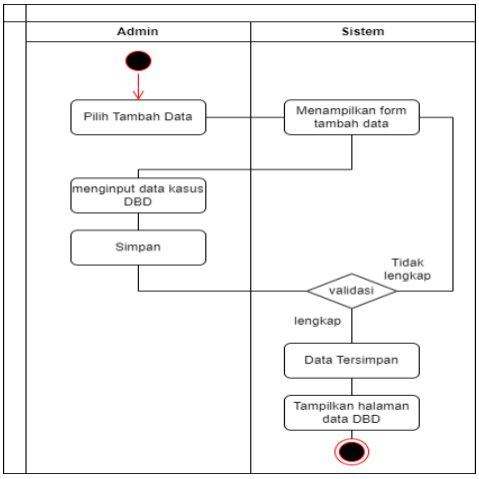

Fig. 4: Activity Diagram Update Data

4.4. Edit Data activities

The figure below explains the activities of the admin in editing the data of dengue cases. The admin can select the data edit menu and the system will display the data edit form, then the admin can make changes to the data which is then saved and will be checked first, if the data entered is complete then the data storage will continue, but if the data entered is incomplete then the admin will fill in or re-edit it.

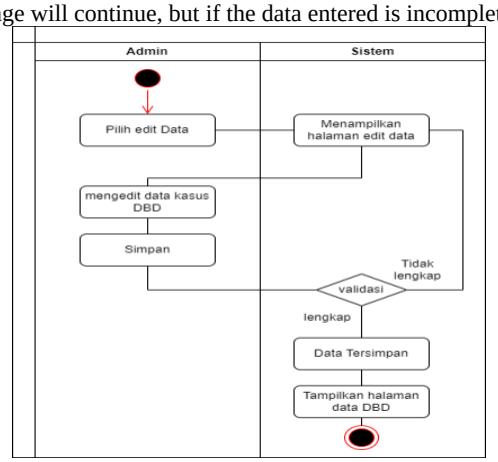

Fig. 5: Activity Diagram Edit Data

4.5. Data Deletion Activity

The figure below explains the activities of the admin in the process of deleting dengue case data. Admin can choose to delete the desired data, and the system will display a choice which will then be confirmed by the admin, if the admin chooses to delete it will be displayed the DBD data menu page, if canceled then the data will not be deleted by the system.

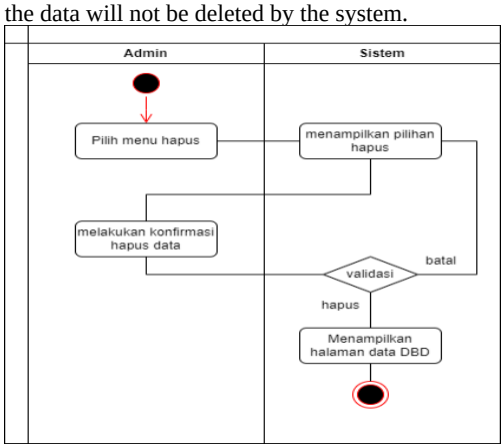

Fig. 6: Activity Diagram Data Delete

4.6. Class Diagram

The Class Diagram below explains the relationship between each class, namely the admin class and the DBD case data class where the admin table is used for login and in the admin table there is a id_admin field as the primary key, username and password are used as login validation to manage dengue case data. The dengue case data table is used for the CRUD Data process, where in this table, there is a field Id_kasus as the primary key, id_desa as the foregn key of the location class, the name that contains the name of the patient, nama_desa contains the name of the village where the patient lives, jenis_kelamin, tgl_kejadian which is loaded based on the time the patient is found, rentan_usia dengue patient, The address of the dengue patient in a specific village, a description, and a status describing the patient's condition (sick, recovered, and deceased). The location table contains field id_desa as the primary key, tahun kejadian, general information about the patient's location, latitude and longitude coordinate points to display the village location points.

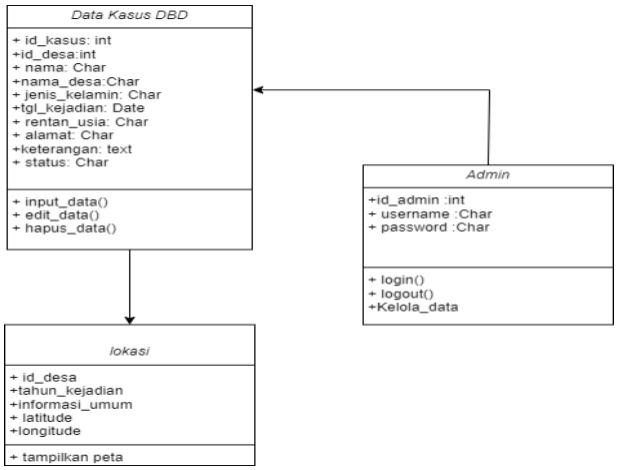

Fig. 7: Class Diagram

System Implementation

1. Login Admin

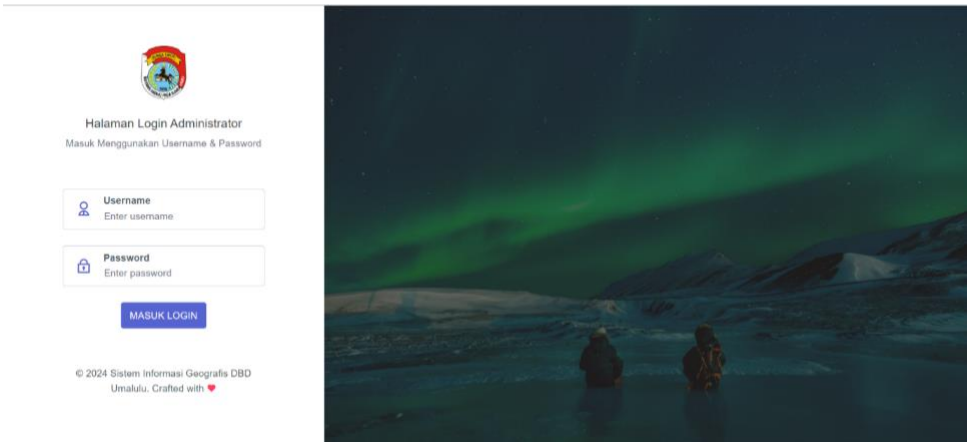

Fig. 8: Admin Login Page

The image above is a login page that contains a username and password form that must be filled in to log in as an admin.

2. Admin Home Page

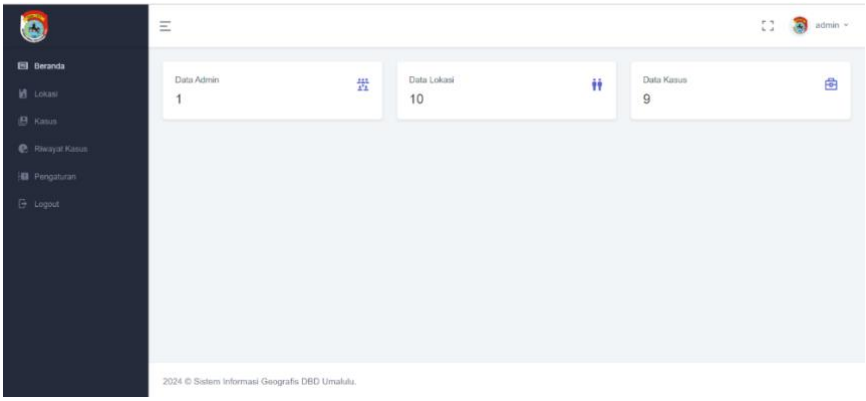

Fig. 9: Admin Home Page

The image above is the home page of the admin, which contains admin data, total location data and total cases that occurred.

3. Location Page

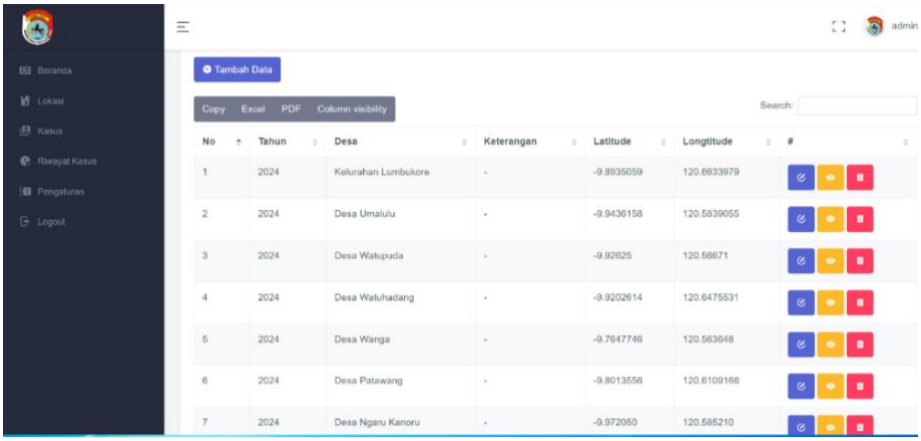

Fig. 10: Village Location Point Page

The image above is the admin location page, where on this page the admin can add, edit, and delete location data and can download data in pdf and excel form.

4. Dengue Cases Page

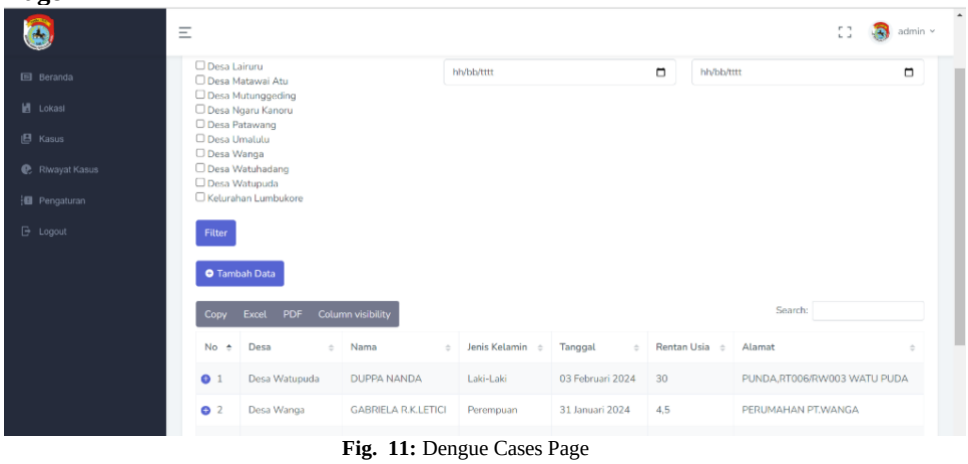

Fig. 11: Dengue Cases Page

The image above is the admin case data page, where admins can add, edit, and delete case data and can also download the case data that is displayed, on the case data page the admin can filter check-box data based on the name of the village and also the date of the incident.

5. Case History Page

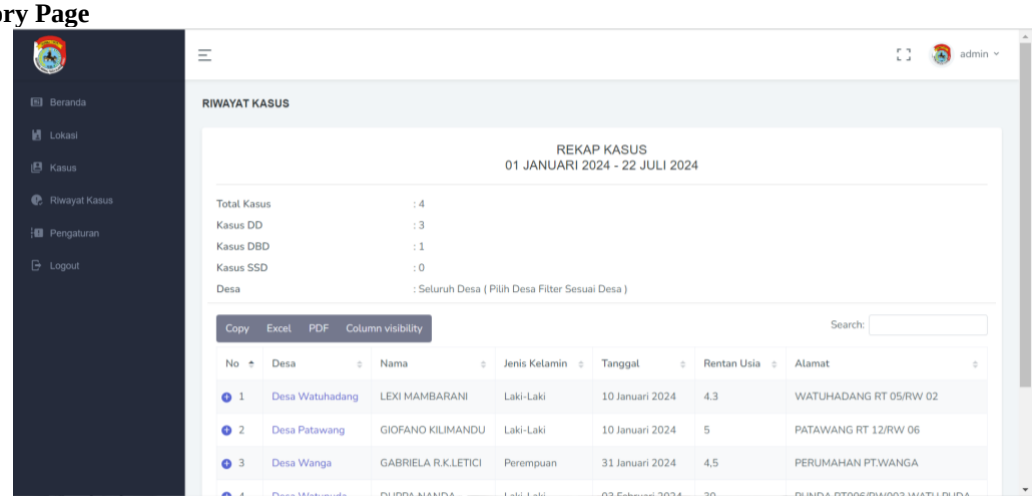

Fig. 12: Case History Page

The image is an admin case history page, where on this page the admin can choose to use the time period that you want to display, and the system will display the recap data as shown above.

6. Visitor Home Page

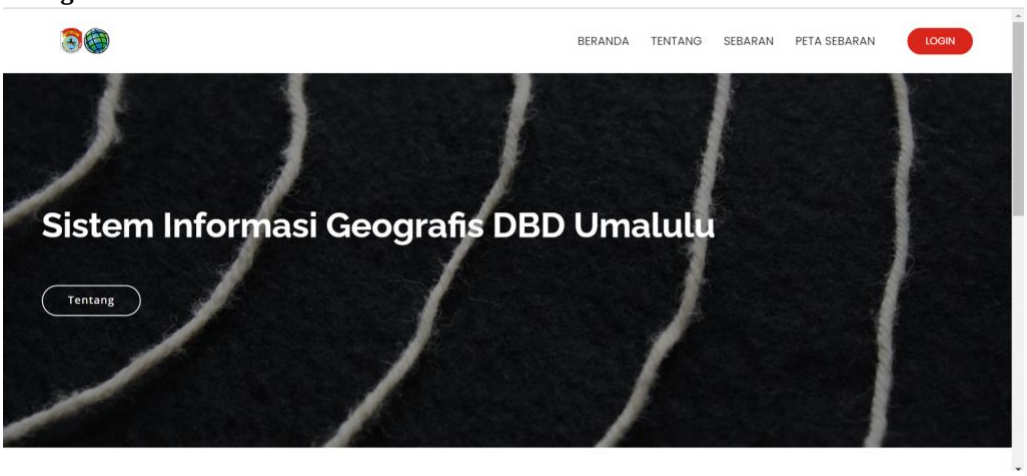

Fig. 13: Visitor Home Page

The image above is a visitor's home page that contains all the features and home menus, about, distribution, and distribution map, for visitors who can access and login for admins.

7. Distribution Page

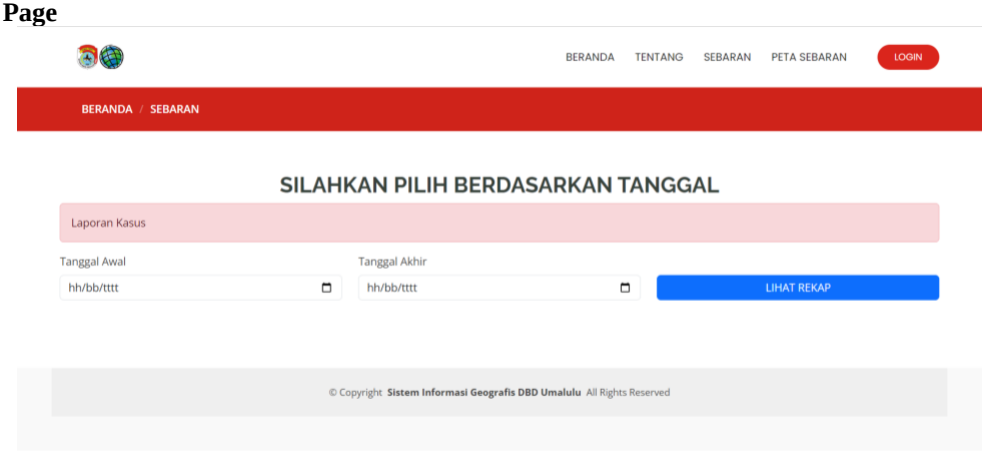

Fig. 14: Visitor Distribution Page

The image above is a distribution page on the visitor page, where visitors can choose to display data based on a time period, and the system will display case summary data.

8. Distribution Map Page

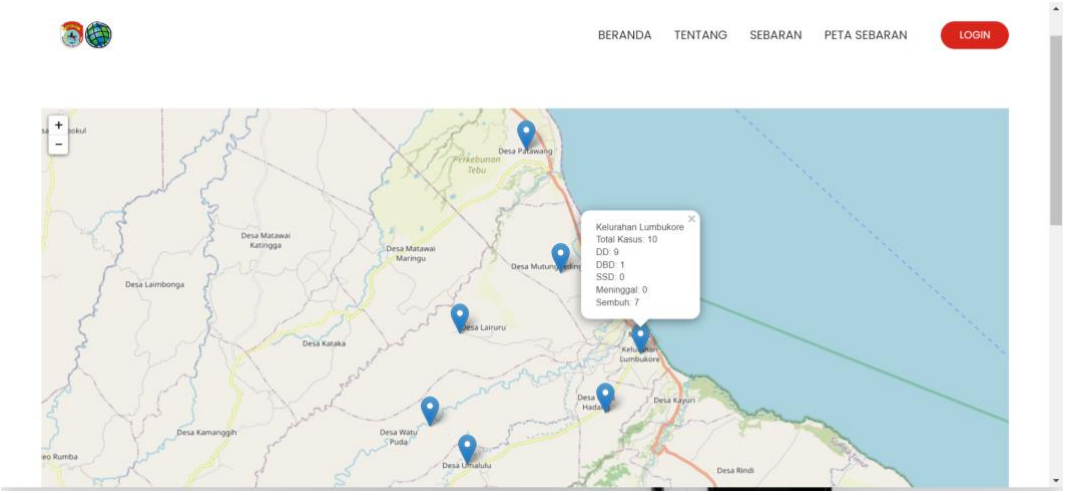

Fig. 15: Dengue Distribution Map Page

The image above is a distribution map menu page where the map above can display the total of all cases based on the village when the point or sign is clicked which consists of the name of the village, the total number of cases in the village, the number of dd, the number of dengue, the number of SSD, the number of deaths, the number of recovered and sick cases.

4.7. Black Box Testing

Black box testing is a type of software testing that focuses on the functionality and external requirements of a system. In black box testing only external interfaces are tested, the tester has no access to or does not consider the source code, internal design, or data structure used in the system.

1. Black Box Admin Testing

Table 1: Black Box Admin Testing

No	Systems Tested	How to Test	Expected Results	Information
1.	Login Admin	Correct Username and Password	The system receives Login access and will then display the admin home page	Successful [√]
		Incorrect Username and Password	The system rejects Login access then will display an alert "Username and Password is not valid"	Successful [√]
2.	Dengue Case Menu	Click the DHF Data menu	A Data table will appear	Successful [√]
		Click the add data icon	An additional data form will appear	Successful [√]
		Click the edit data icon	A data edit form will appear	Successful [√]
		Click the delete data icon	A confirmation will appear to delete the data and the data is deleted	Successful [√]
		Click on the Data Type Selection you want to download	Data will be downloaded in the form of PDF or Excel files	Successful [√]
		Filter check-boxes by village name and date	Displays the case data page according to the options on the check-box	Successful[√]
3.	Location map menu	Click the add data icon	An additional data form will appear	Successful [√]
		Click the edit data icon	A data edit form will appear	Successful [√]
		Click the delete data icon	A confirmation will appear to delete the data and the data is deleted	Successful [√]
		Click on the Data Type Selection you want to download	Data will be downloaded in the form of PDF or Excel files	Successful [√]
4.	Case History Menu	View Case history based on the specified start and end dates	Case Recap data will appear according to the date entered	Successful [√]
		Click the Select of the Type of Capture Data you want to download	Data will be downloaded in the form of PDF or Excel files	Successful [√]
5.	Settings Menu	Admin Can Change Username and Password and About	Displaying new Usernames and Passwords and About	Successful [√]
6.	Admin Logout	Click the logout button	Will return to the login page	Successful [√]
7.	Search	Write search criteria	A display will appear according to the search	Successful [√]

2. Black Box Visitor Testing

Table 2: Black Box Visitor System test table

No	Systems Tested	How to Test	Expected Results	Information
1.	Home Menu	Click the home menu	Case Recap data will appear according to the date entered	Successful [√]
		Click the About menu	Displaying About Pages	Successful [√]
2.	Case Distribution Data Menu	View Case history based on the specified start and end dates	Case Recap data will appear according to the date entered	Successful [√]
3.	Menu of dengue case spread map	Click the DHF Distribution Map menu	A map of the distribution of dengue fever will appear	Successful [√]
		Zoom Peta	Maps will Look Big	Successful [√]
		Click the Dots icon on the map	There will be a difference from the point on the clicked map	Successful [√]
4.	Search	Write search criteria	A display will appear according to the search	Successful [√]

5. Conclusion

After analyzing, designing, implementing and testing the geographic information system for mapping the dengue fever distribution area in Umalulu sub-district, this system successfully displayed a map of the distribution of dengue fever cases in each village, calculated all the total cases displayed on the map, made it easier for managers to store data and maintain data,. So it can be concluded that the implementation has been completed and testing using black boxes has successfully shown that the website can operate according to its function without errors.

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