Section A-Research Paper
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DEVELOPMENT OF GEOGRAPHIC INFORMATION SYSTEM PROGRAM AND MOSQUITO LARVAE MONITORING BY CADRES IN ACEH BESAR REGENCY

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ABSTRACT

The development of a Web-based Geographic Information System and Mosquito Larvae Monitoring Program by Cadres has been successfully implemented as a solution to facilitate the cadres in conducting larvae monitoring surveys. The main objective of this research is to monitor the number of mosquito larvae in Aceh Besar District using a more efficient method and provide real-time mappable information. In this endeavor, a dedicated programming program was designed to facilitate the cadres in quickly collecting and securely storing larvae data, which can be directly accessed by the Public Health Center (Puskesmas) and the public. Consequently, preventive measures against Dengue Fever (DF) can be promptly implemented. This program is known as the Geographic Information System and Larvae Monitoring Program (SIG-PJ). The SIG-PJ application caters to three user types: cadres, administrators, and the public. Cadres are responsible for conducting surveys and inputting larvae data, while administrators manage and oversee the data. The application's dashboard in SIG-PJ allows the public to view a comprehensive summary of larvae data, including the total number of larvae, the overall coverage area, the results of larvae data from all villages, a distribution map of larvae, and an index value derived from the entire dataset. This information aids in identifying high-risk areas and implementing targeted prevention strategies.

Keywords: Automatic Program Development, Geographic Information System (GIS), larvae monitoring survey.

INTRODUCTION

Each year, it is estimated that there are approximately 390 million new infections of the dengue virus worldwide, including around 96 million cases with diverse clinical manifestations ranging from asymptomatic infections to severe and life-threatening dengue hemorrhagic fever [(1)]. Dengue, caused by the dengue virus transmitted by Aedes aegypti mosquitoes, can result in symptoms such as high fever, joint and muscle pain, rash, and a decrease in platelet count [(1)]. In severe cases, dengue hemorrhagic fever can lead to bleeding, shock, and death if not promptly and properly managed [(2)]. Global data indicates that dengue is a significant health burden, affecting many

countries worldwide [3,4]. Therefore, efforts to prevent and control dengue are crucial in reducing the incidence, complications, and deaths associated with this disease.

In 2019, Aceh experienced an increase in cases of dengue fever, with a total of 2,386 cases and six deaths (5). This information is based on the Health Profile of Aceh Province in 2019, published by the Provincial Health Office of Aceh. The incidence rate (IR) of dengue fever in that year also increased compared to the previous year, from 29 to 44 per 100,000 population (6). However, there was a decrease in the case fatality rate (CFR) from 0.26% in 2018 to 0.25% in 2019 [6].

The report also highlights that three districts/cities in Aceh had high CFR rates in 2019, namely Aceh Jaya (2.56%), Nagan Raya (1.47%), and Kota Langsa (1.10%) [7]. Efforts to improve healthcare services and increase public awareness are essential in addressing this situation. The increase in dengue cases is influenced by the peak of the rainy season that occurs during the year-end transition. The humid climate and cool environmental temperatures during the peak of the rainy season create favorable conditions for the development of Aedes aegypti mosquito larvae [2]. To minimize the impact of dengue fever (DBD), it is important to increase public awareness of the symptoms of DBD and the importance of seeking immediate medical attention if experiencing these symptoms. A reference from the study "Dengue Hemorrhagic Fever in Aceh, Indonesia" published in Acta Medica Indonesiana also emphasizes the need to improve knowledge and understanding of DBD among the community [8]. In another study published in the Journal of Infection and Public Health, Sharma et al. (2019) analyzed a dengue outbreak in Aceh Province and highlighted the importance of epidemiological analysis in managing such outbreaks. Through collaborative efforts between the government, healthcare professionals, and the community, it is hoped that the spread of DBD can be controlled and its negative impacts reduced [9]. The implementation of Geographic Information System (GIS) technology in mosquito surveillance enhances efficiency and accuracy in data collection, mapping mosquito distribution, and planning more effective prevention strategies, particularly in urban areas [10]. The information obtained from the use of GIS serves as a foundation for taking more precise and targeted preventive measures [11].

The increase in DBD cases in the Aceh Besar District, particularly in the sub-districts of Darul Imarah, Darul Kamal, Simpang Tiga, and Krueng Barona Jaya, which are densely populated areas, highlights the need for identifying the number and distribution of cases, as well as the severity of the disease within the population. However, manual surveillance activities conducted by village cadres are considered inefficient and less accurate. Challenges often arise in reporting to health centers, and the monitoring of mosquito larvae in households is often not implemented. Therefore, the development of a Geographic Information System (GIS) Program and mosquito larvae monitoring by cadres is expected to be a solution. This program allows for more efficient data collection through smartphone technology and utilizes GIS for spatial analysis and visualization of disease and environmental patterns. Consequently, the management of DBD cases is expected to be more effective and efficient. Thus, the objective of this research is to monitor the number of mosquito larvae in Aceh Besar District using a more efficient method and provide mappable information through the development of a Geographic Information System (GIS) Program.

METHODOLOGY

This study developed an application to facilitate cadres in obtaining mosquito larvae data using an online data collection system inputted by the cadres. Additionally, the researchers also trained the mosquito larvae surveillance cadres in using the application and implemented it directly to the community. The population of this study included all mosquito larvae surveillance cadres in the Aceh Besar District, while the research sample was taken from the mosquito larvae surveillance cadres in the Darul Imarah Sub-district of the Aceh Besar District. The independent variable in this

study was the mosquito larvae monitoring inputted by the cadres, while the dependent variables included DBD cases and population density. The research was conducted in the Aceh Besar District. In the previous stages of the research, the potential and problems in manually conducting mosquito larvae surveillance surveys using paper were identified. Therefore, the researchers conducted a study on online mosquito larvae monitoring by the cadres through an application to ensure data accuracy and sustainability.

The next stages of the research included research preparation, data collection, and measurable achievement indicators in each stage. The research team consisted of two individuals, with one serving as the leader and the other as a research member assisting them. Additionally, this research involved an expert consultant in application development and an admin responsible for application control and data processing. In the research preparation stage, the process of obtaining permits, ethical clearance, and conducting the research site survey were carried out. The data collection stage involved the design of the SIG-PJ application by the consultant, validation of the design by the researchers, and revisions if necessary. Subsequently, the prototype was created, the prototype results were validated, revisions were made if necessary, and the SIG-PJ application was developed by the consultant. Afterward, the village cadres underwent application implementation training through trials and finally could report field surveys through the application after becoming proficient in its use. The measurable achievement indicators in each stage of the research were the formation of the application and its implementation in the field.

RESULTS

The result of this study is the Geographical Information System and Mosquito Larvae Monitoring Application (SIG-PJ) https://www.sigpj-poltekkesaceh.com/. This application provides easier, faster, more efficient, and accurate information compared to surveys conducted using paper and Google Forms, enabling the prevention of dengue fever. The application has three users: the public, cadres, and administrators. The following are the display results of the SIG-PJ Application:

Public View:

In the public view, anyone accessing the SIG-PJ Application can see the survey results of mosquito larvae data. The public can view the overall data, mosquito larvae data, distribution map of mosquito larvae, and the index value. The public view can be seen as follows:

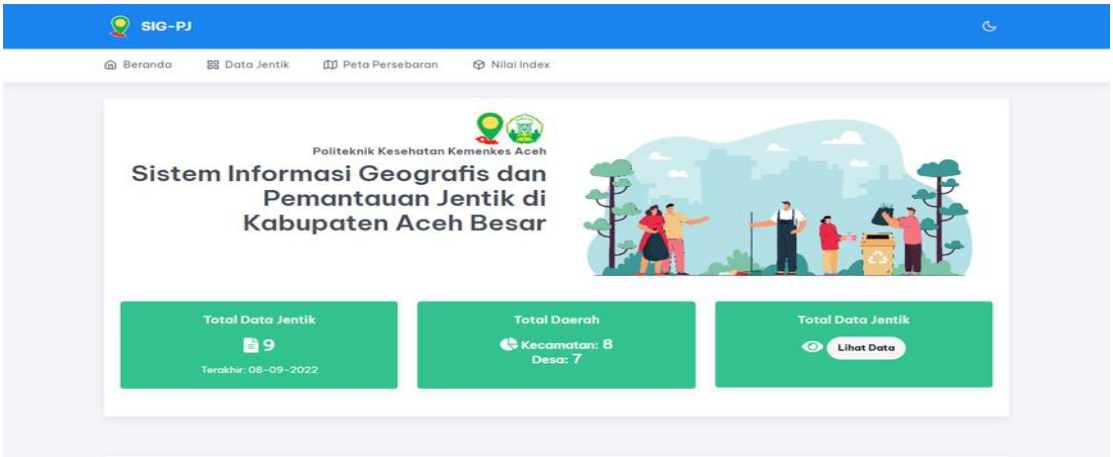

Figure 1 shows the view from the homepage of the SIG-PJ Application

In Figure 1, it can be seen that the initial display of the SIG-PJ application shows a homepage that provides users with access to view information about the total number of mosquito larvae data and

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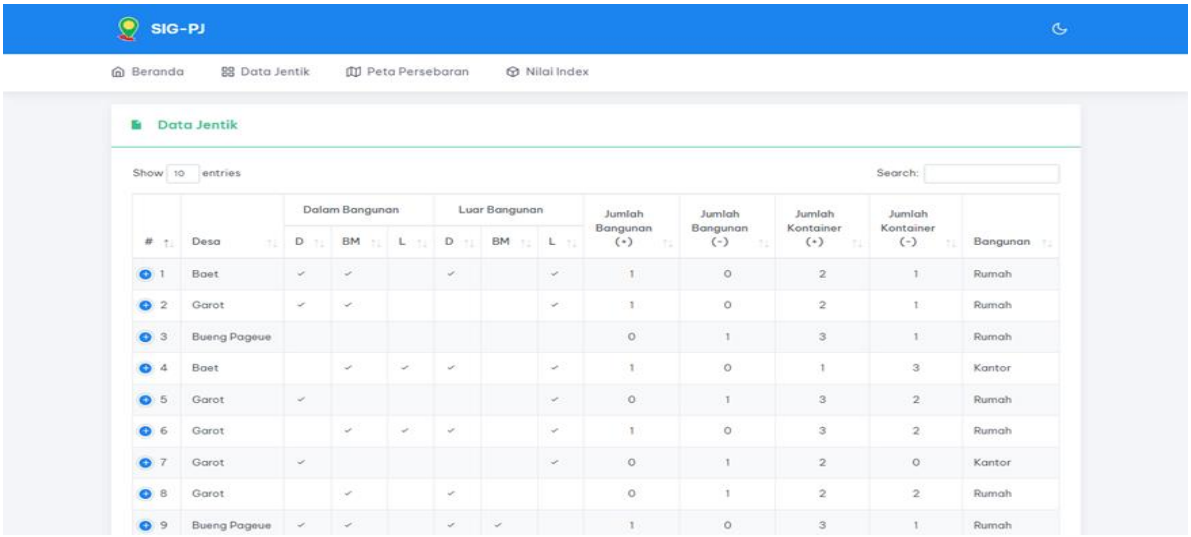
the total affected areas. On this homepage, users can easily see a summary of data related to mosquito larvae and the affected areas. If users want to explore more about the overall mosquito larvae data, they simply need to click on the "view data" option provided.



#	Desa	Dalam Bangunan D	Dalam Bangunan BM	Dalam Bangunan L	Luar Bangunan D	Luar Bangunan BM	Luar Bangunan L	Jumlah Bangunan (+)	Jumlah Bangunan (-)	Jumlah Kontainer (+)	Jumlah Kontainer (-)	Bangunan
1	Baet	✓	✓		✓		✓	1	0	2	1	Rumah
2	Garot	✓	✓				✓	1	0	2	1	Rumah
3	Bueng Pageue							0	1	3	1	Rumah
4	Baet		✓	✓	✓		✓	1	0	1	3	Kantor
5	Garot	✓					✓	0	1	3	2	Rumah
6	Garot		✓	✓	✓		✓	1	0	3	2	Rumah
7	Garot	✓					✓	0	1	2	0	Kantor
8	Garot		✓		✓			0	1	2	2	Rumah
9	Bueng Pageue	✓	✓		✓	✓		1	0	3	1	Rumah

Figure 2 displays the view of the mosquito larvae data results from all the villages

In Figure 2, it is evident that the SIG-PJ application displays the results of mosquito larvae data from all villages in the Darul Imarah District, accessible to the public. Through this application, the public can easily access relevant information about the detected number of mosquito larvae in each village. This provides a comprehensive overview of the presence of mosquito larvae in the area and helps the public understand the associated risk level of dengue fever. With transparent access to mosquito larvae data, the public can become more aware of their surrounding environment and take necessary preventive measures.

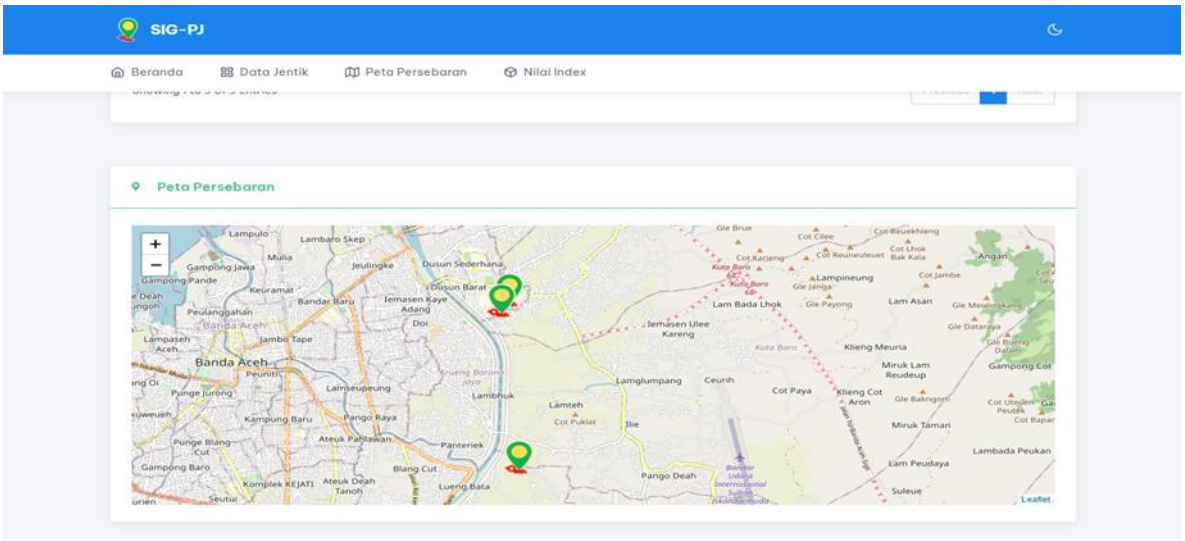


Figure 3 illustrates the map view of the distribution of mosquito larvae data.

In Figure 3, it is evident that the SIG-PJ application presents a map depicting the distribution of mosquito larvae. This map provides a clear and detailed visualization of the mosquito larvae distribution across the entire Darul Imarah District. By examining this map, the public can easily identify areas with high or low density of mosquito larvae. This information is highly valuable in the efforts to prevent dengue fever, as the public can identify areas that are vulnerable to mosquito infestations and take appropriate measures to control the mosquito population. Thus, the distribution map of mosquito larvae presented through the SIG-PJ application provides valuable insights for the public to take more effective preventive actions and minimize the risk of dengue fever transmission.

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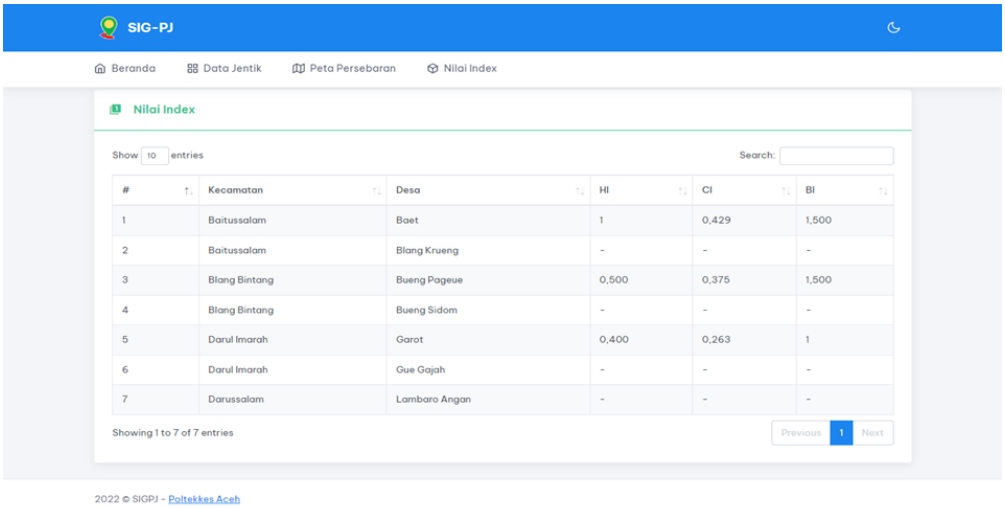

Figure 4 showcases the display of the larval index value

Figure 4 displays the interface presenting the index values derived from the overall data received by the SIG-PJ application. These index values are automatically calculated by the application based on the data collected through mosquito larvae surveys conducted by the field workers. This display provides information to the public regarding the index values that reflect the presence of Aedes aegypti mosquito larvae in a specific area. The index serves as a reference to evaluate the level of risk and the effectiveness of mosquito larvae eradication efforts in managing dengue fever. Through this display, the public can directly observe the calculated index values provided by the SIG-PJ application. This promotes transparency and openness in sharing information regarding the presence of mosquito larvae in different areas, enabling the public to have a better understanding of the dengue fever situation in their respective regions. By utilizing the information presented in the index value display, the public can take appropriate actions in response to the risk of dengue fever. They can raise awareness about the importance of mosquito larvae prevention and control, as well as collaborate with relevant authorities to strengthen dengue fever eradication efforts. Overall, this display enhances accessibility and public engagement in monitoring and undertaking preventive measures regarding dengue fever transmission. With transparent and accurate information, it is expected to increase community participation in effectively preventing and controlling dengue fever.

Display for cadres

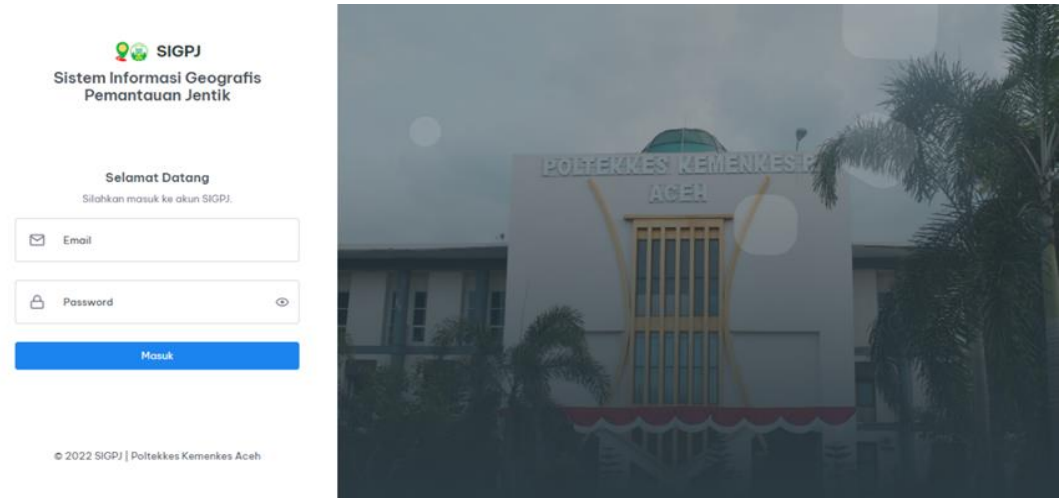

Figure 5 displays the login interface for both kader (field workers) and admin.

In Figure 5, we can observe the login page specifically designed for field workers (kader) and administrators in the SIG-PJ application. This display features a login form where field workers and administrators can enter their respective usernames and passwords. By using valid credentials, field workers and administrators can access the areas appropriate to their roles in the application. For field workers, upon

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successful login, they gain access to specific features that enable them to directly collect and input mosquito larvae data. They can utilize the application as an efficient tool to report field survey results and monitor the progress of mosquito larvae in their respective areas. Thus, they can actively contribute to the efforts in preventing dengue fever. Meanwhile, for administrators, after logging in, they receive broader access rights to control and manage the application. This includes data management, information processing, and overall application maintenance. Administrators are responsible for ensuring the sustainability and accuracy of the data collected through the application, as well as taking necessary actions to maintain the security and continuity of the application. By providing separate login interfaces for field workers and administrators, the SIG-PJ application ensures that only authorized users with appropriate permissions can access and utilize the provided features. This is an important step in maintaining the security and integrity of the data within the application.

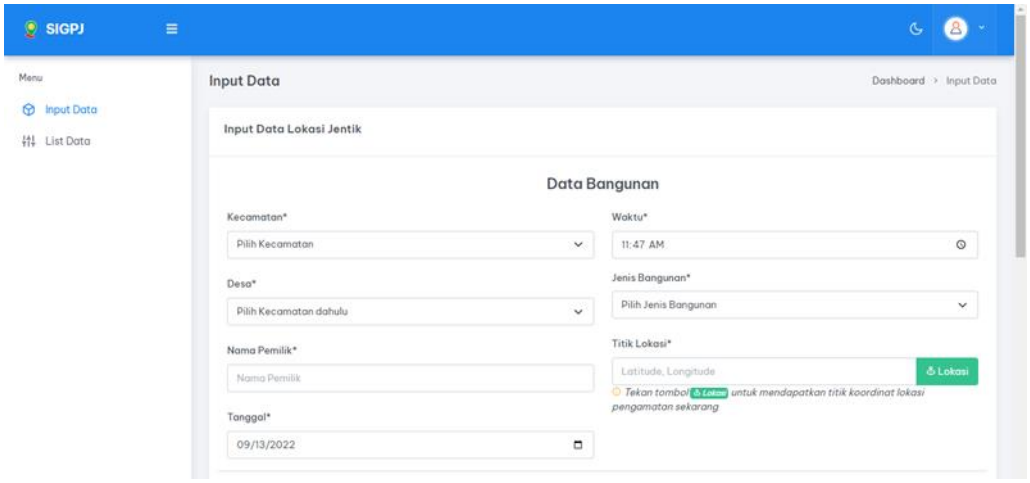

Figure 6 illustrates the questionnaire for inputting larval data in the SIG-PJ Application by kader (field workers)

In the SIG-PJ application, the process of monitoring mosquito larvae is conducted through the completion of a questionnaire by field workers. Figure 6 illustrates the contents of the questionnaire that must be carefully filled out by the field workers. This questionnaire includes important information such as the survey location, homeowner data, as well as the date and time of the survey. Field workers are also asked to specify the type of building being surveyed and mark the exact location of the surveyed house. Additionally, the questionnaire includes a section that allows field workers to mark containers found to be positive for mosquito larvae.

By checking the appropriate boxes, field workers can report containers that are positive for larvae. Furthermore, field workers are expected to input the number of buildings with positive and negative containers, as well as the number of positive and negative containers within a single house. By accurately and carefully completing this questionnaire, field workers can provide vital information for mosquito monitoring. The data collected through this application provides a more comprehensive overview of mosquito larvae distribution in a given area, enabling the identification of vulnerable areas to diseases and supporting more effective decision-making in disease prevention and control efforts caused by Aedes aegypti mosquitoes. The SIG-PJ application helps expedite the survey process, improve data accuracy, and allows for more efficient analysis for disease monitoring and control purposes.

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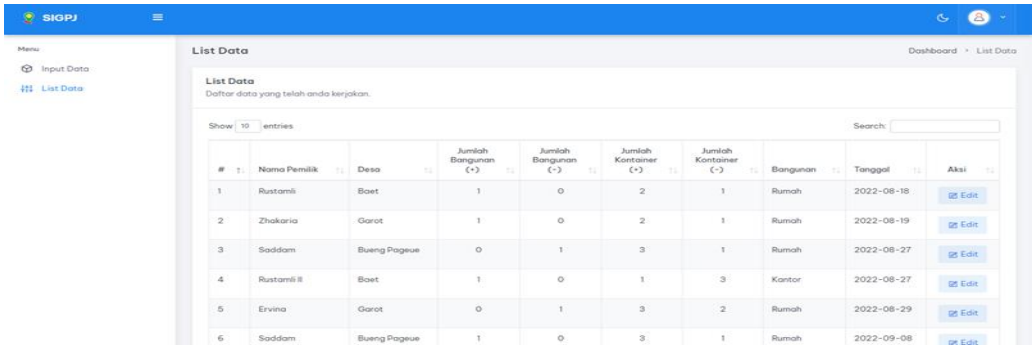

Figure 7 showcases the display of the list of data inputted by kader in the kader dashboard

In Figure 7, we can see the display of a data list showing the input results from field workers, which can be viewed in the SIG-PJ application. In this display, there is a table presenting information about mosquito larvae data that has been input by field workers from various regions. In the table, each row represents a data entry consisting of various attributes such as the input date, village or sub-district name, the number of mosquito larvae found, and other relevant information. With the use of this data list view, field workers can easily see and monitor the progress of the larvae survey they have conducted.

This data list view provides an overview of the collected mosquito larvae data by field workers, allowing them and relevant parties to perform further analysis on the distribution and density of mosquito larvae in various regions. Thus, this view facilitates monitoring and evaluation of the efforts to prevent and control dengue fever carried out by field workers. Additionally, this data list view can also be used as a reference for administrators and other relevant parties to comprehensively review the results of the larvae survey conducted by field workers. The information contained in this data list assists in decision-making related to dengue fever prevention and control efforts in relevant areas. With a clear and structured data list view, the SIG-PJ application provides convenience in managing and utilizing the collected mosquito larvae data by field workers to support dengue fever prevention and control activities.

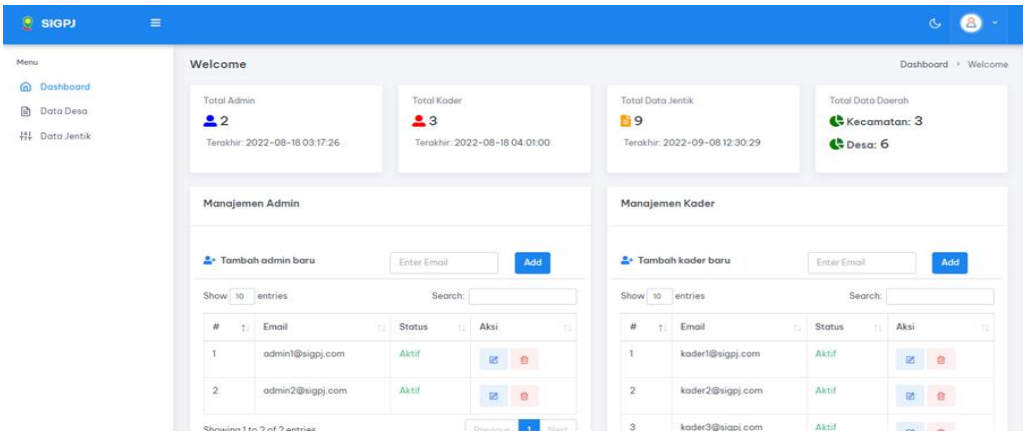

Figure 8 displays the interface for the admin in the SIG-PJ application.

Display for Admin

Figure 8 depicts the interface of the admin dashboard in the SIG-PJ application. Through this dashboard, an admin has access and full control over the application management. One of the available features is the ability to register new users, both field workers (kader) and new admins. By registering new users, the admin can expand the network of field workers involved in larvae monitoring and strengthen the team involved in addressing dengue fever cases. Furthermore, the admin dashboard provides relevant information about users and the collected data. The admin can view the total number of registered admins in the application, giving an overview of the administrative team's size. Additionally, the admin can see the total number of registered field workers, indicating the extent of the active field worker network involved in larvae monitoring. Moreover, the admin dashboard presents information about the larvae data and the

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regional data inputted by field workers. This information is valuable in understanding the success of larvae monitoring and the level of field worker involvement in data collection. The admin can see the number of collected larvae data, reflecting the effectiveness of monitoring Aedes aegypti mosquito larvae. Furthermore, the admin can also view the number of regional data inputted by field workers, providing an overview of the extent of larvae monitoring coverage in various regions. With this informative and functional admin dashboard, the admin can easily manage users, monitor field worker activities, and gain valuable insights into larvae data collection and field worker involvement in addressing dengue fever cases. This enables the admin to take appropriate steps in managing and developing the SIG-PJ application, as well as enhancing effectiveness in addressing dengue fever cases in the targeted areas.

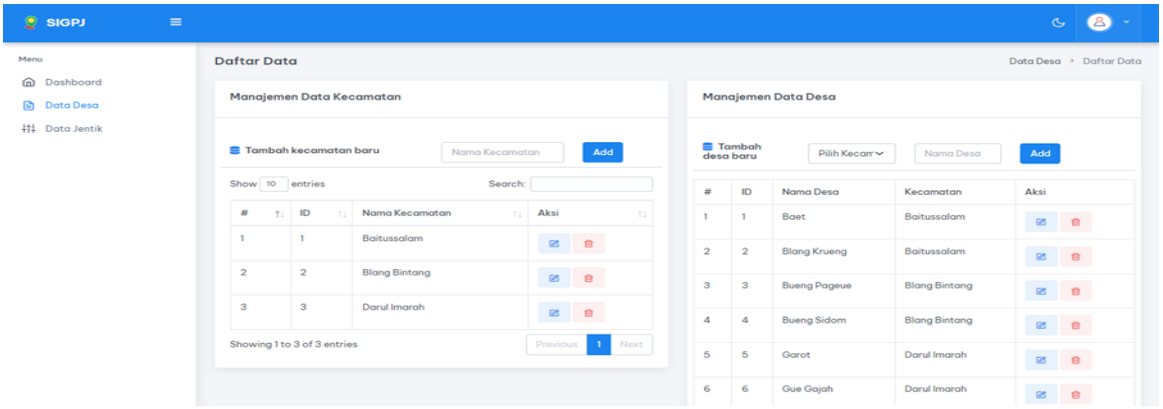

Figure 9 showcases the input interface for the admin in the SIG-PJ application, specifically for entering district and village data

Figure 9 displays the interface that demonstrates the admin's ability to input sub-district (kecamatan) and village (desa) data in the SIG-PJ application. The admin has the authority and responsibility to ensure the accuracy and completeness of information related to the sub-districts and villages covered in the application. Through this interface, the admin can access the provided form or fields to systematically input sub-district and village data. The admin will fill in the required information, such as the names of the sub-districts and villages to be included in the application. This data input process is crucial to ensure that the geographic and administrative data related to the mosquito larvae survey locations are accurately recorded. By inputting sub-district and village data accurately, the admin can ensure that every relevant area in dengue fever management is covered in the SIG-PJ application. This facilitates the identification and analysis of more detailed data based on geographic locations, enabling more informed decision-making in dengue fever control efforts. The admin's ability to input sub-district and village data in the SIG-PJ application demonstrates that the application is designed to be a comprehensive and accurate tool in monitoring and addressing dengue fever cases in various regions

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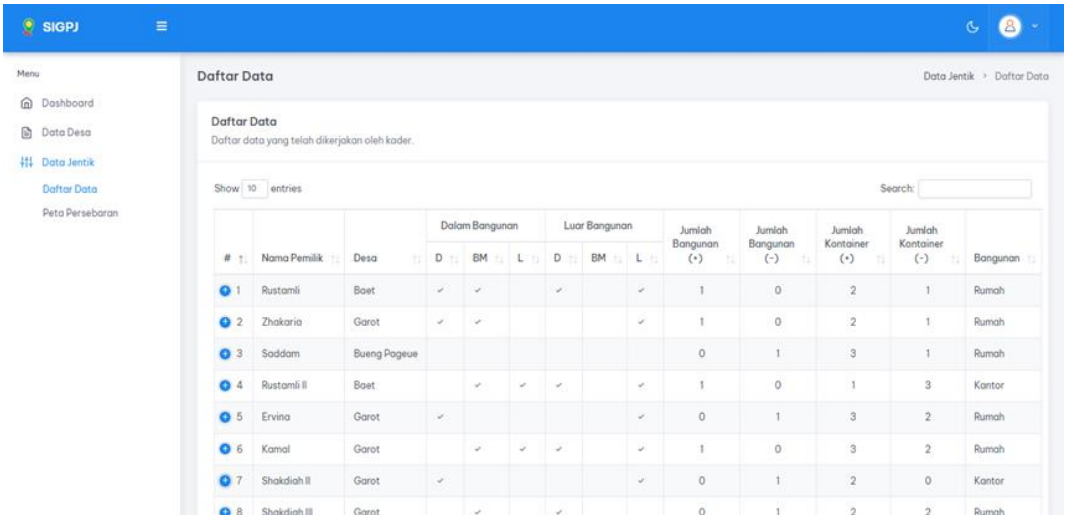

Figure 10 displays the interface that shows the village data entered by the kader in the SIG-PJ application.

Figure 10 displays the interface that showcases the admin's ability to monitor all the mosquito larvae data inputted by field workers through the SIG-PJ application. In this view, the admin can comprehensively see all the data collected by the field workers regarding the presence of mosquito larvae in various locations. The admin has full access and control over the data recorded in the application. If there are any errors or inconsistencies in the data, the admin has the ability to correct or delete inaccurate or irrelevant data. This is important to ensure that the data presented in the application is consistent, accurate, and reliable.

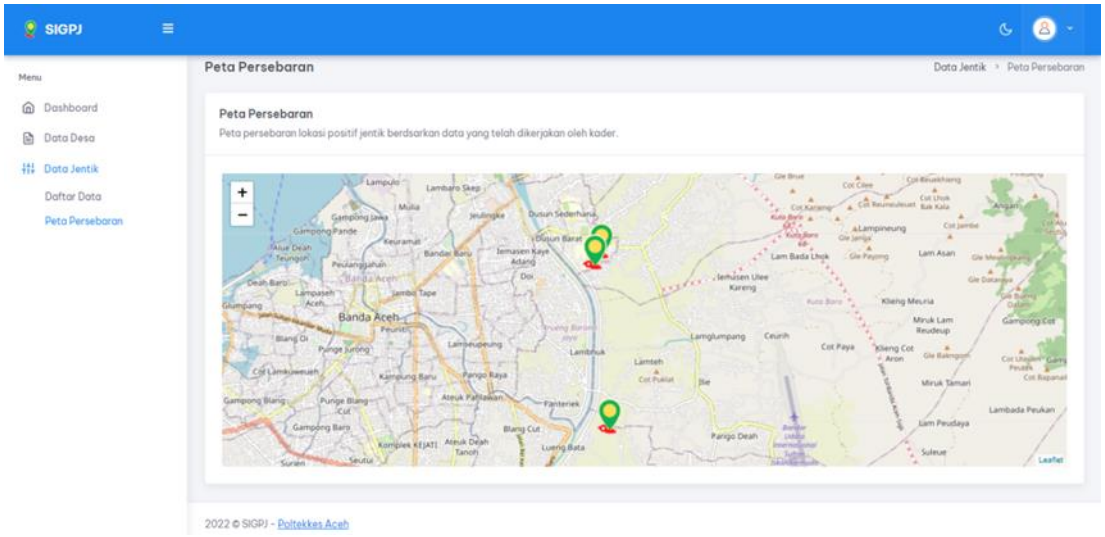

Figure 11 showcases the map display within the admin user interface, highlighting the distribution of jentik data.

Figure 11 depicts the interface in the admin user view that allows the admin to view the map of mosquito larvae distribution in real-time. In this view, the admin can easily access information about locations where mosquito larvae have been found based on the data collected by field workers. Through the mosquito larvae distribution map, the admin can quickly visualize areas that are vulnerable to mosquito larvae infestation. This information is crucial in taking appropriate prevention and control measures to reduce the risk of Dengue Hemorrhagic Fever (DHF) outbreaks.

DISCUSSIONS

Before the research was conducted, the mosquito surveillance volunteers (jumantik cadres) conducted surveys by manually recording data on paper questionnaires by visiting residents' homes. However, there

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were often challenges where the questionnaires would get lost or there would be issues with the reporting process, resulting in data not being smoothly transmitted to the local health centers (puskesmas). Faced with this situation, the researchers decided to change the method of mosquito surveillance survey by using Google Forms as a tool for online questionnaire filling. Although the use of Google Forms provided convenience in the data collection process, there were still some challenges and delays in obtaining reports. Therefore, the researchers developed a mosquito surveillance system in the form of a web-based application. This application was designed with the main goal of facilitating and simplifying the mosquito surveillance process for the volunteers, administrators, and puskesmas in obtaining the necessary data reports. The collected survey data using this application brings many benefits to all parties involved. For the volunteers, they can easily fill out the questionnaire through the application, input data quickly, and send reports directly. Administrators also benefit by having direct access to the mosquito data collected by the volunteers through this application. As for the puskesmas, they can obtain real-time mosquito data reports, monitor the situation's progress, and take faster and more accurate preventive actions

This application also provides advantages in terms of efficiency compared to surveys using paper or Google Forms. The data collected through the application can be easily processed and analyzed, minimizing errors and the time required for manual data processing. The speed and accuracy of the information generated from this application are crucial in the efforts to prevent Dengue Hemorrhagic Fever (DHF). In comparison to surveys using paper-based instruments or Google Forms, this application shows significant differences. Apart from providing convenience in questionnaire filling and data collection, the application also offers additional features such as mosquito distribution maps and a dashboard view that facilitates administrators in monitoring and managing the collected mosquito data. All of these aspects represent a significant advancement in enhancing the efficiency and effectiveness of mosquito surveillance surveys, while contributing to the efforts of preventing and controlling dengue fever.

Table 1: Comparison of Jentik Survey Results across Different Instruments

	Paper-based Instrument	**Google Form**	**Web-based Application**
Ease of Data Entry	Impractical	More practical	Very practical
Data Loss	Vulnerable	Low	Very low
Reporting	Not smooth	Low	Direct and smooth
Access to Data	Limited	Limited	Direct and comprehensive
Progress Monitoring	Difficult	Difficult	Easy and real-time
Additional Features	None	Limited	Available and comprehensive
Processing Efficiency	Manual	Manual	Automated and fast
Effectiveness of Control	Limited	Limited	Improved

The table above shows a comparison of the results of mosquito surveillance using different instruments, namely paper-based instrument, Google Form, and web-based application. The web-based application demonstrates significant differences compared to the other instruments. This application provides ease of questionnaire filling and data collection, includes additional features such as mosquito distribution maps and a user-friendly dashboard for administrators, and achieves higher efficiency and effectiveness in mosquito surveillance. This contributes to better efforts in preventing and controlling dengue fever. The Geographical Information System and Mosquito Monitoring Application (SIG-PJ) is a web-based information system that provides services to three types of users: field workers (kader), administrators (admin), and the general public. Each user has different functions and access rights within the system. Firstly, field workers are registered users managed by the administrators.

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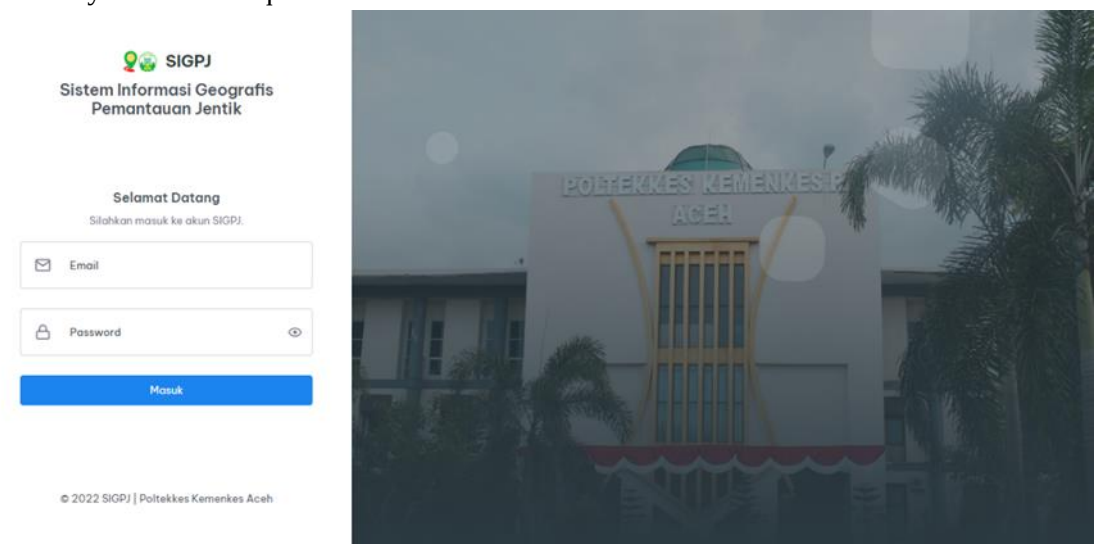
They can input mosquito data into the system, view previously entered data, and edit data if necessary. Secondly, administrators have special accounts that allow them to register field worker accounts using their phone numbers. Admins also have the ability to input, view, edit, and delete regional data such as villages and districts. Additionally, administrators can view and update mosquito data entered by field workers. Thirdly, the general public does not require an account to access the information provided by the SIG-PJ application. They can access the homepage, landing page menu, mosquito data, mosquito distribution maps, and index values. The information available to the general public includes a summary of mosquito surveillance, a list of mosquito data, mosquito distribution maps, and index values. The usage of the SIG-PJ application by field workers involves the process of account registration by the administrators, so field workers do not need to register themselves. After receiving their account information provided by the admin, field workers can log into their accounts using their username (or registered email) and a predetermined password. This provides field workers with easy and quick access to the features of the SIG-PJ application. With the SIG-PJ application, it is expected that users, including field workers, administrators, and the general public, can easily manage mosquito data, access relevant information, and efficiently monitor mosquito distribution.



After successfully logging in, the field worker will be directed straight to the page for inputting new data in the SIG-PJ application. The system automatically sets the date and time of implementation, but the field worker still has the ability to modify them if needed. To obtain accurate location data, the field worker can press the green "Location" button as seen in the image. The data that needs to be inputted by the field worker is divided into three categories: building data, item data, and mosquito data. Each category has its own form that needs to be filled out by the field worker. After filling out all the required data, the field worker can use the "Submit" button to save the inputted data. However, if the data is not meant to be saved, the field worker can use the "Reset" button to clear the form and start inputting new data. In the provided image, the data that needs to be filled out by the field worker in the SIG-PJ application is clearly visible. This helps the field worker enter the necessary information completely and accurately. With these features, the use of the SIG-PJ application becomes more efficient and facilitates the field worker in carrying out mosquito monitoring tasks.

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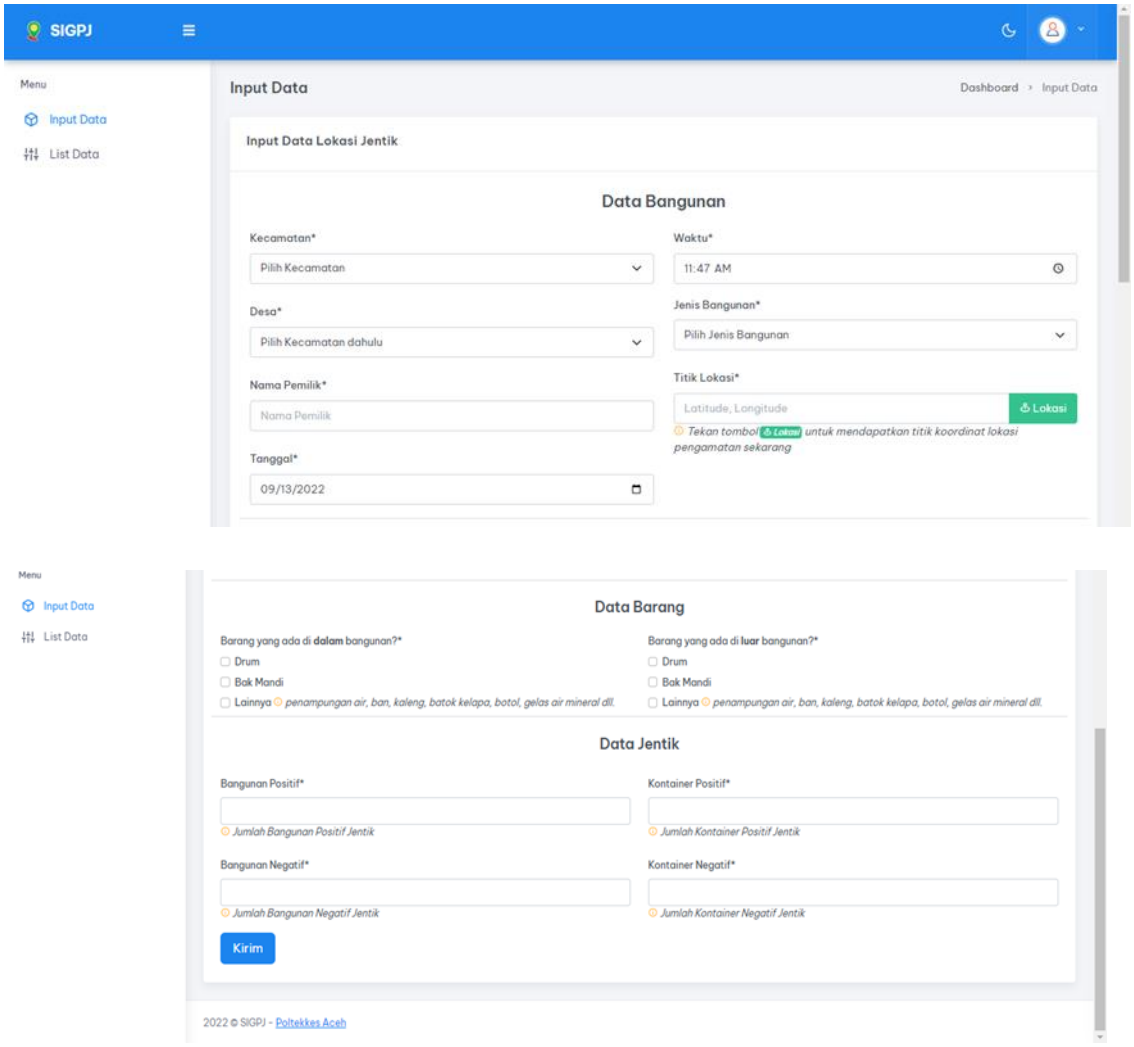

After the field worker successfully inputs data, they can view the list of data they have entered on the "List Data" page. This page displays the data that the field worker has inputted. The field worker is also given the ability to make changes to previously entered data. On the "List Data" page, the field worker can see the list of data they have previously inputted. Each displayed data is accompanied by a green "Edit" button in the action column. By clicking on the "Edit" button, the field worker can make changes to the data they want to modify. It is important to note that the list of data displayed on this page is limited to the data inputted by the respective field worker. This ensures that the field worker can only view and modify data relevant to their tasks and responsibilities. With the presence of the "List Data" page and the provided edit feature, the field worker has full control over the data they have entered. They can easily make changes if there are any errors or updates needed in the data. This provides flexibility and convenience for the field worker in managing and updating mosquito monitoring data.

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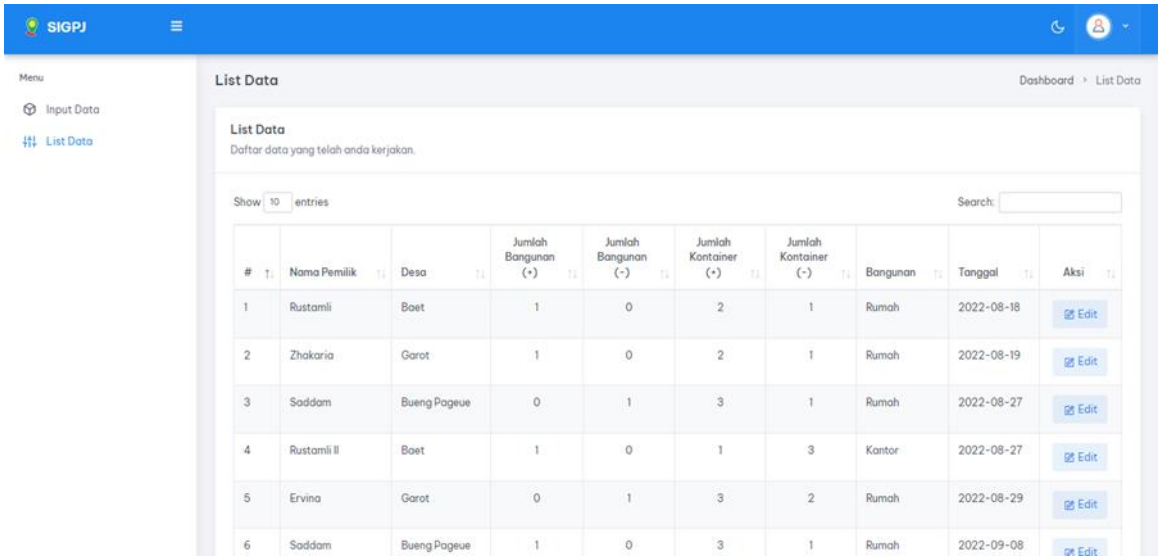

In addition to managing mosquito monitoring data, field workers are also given the ability to update their profile and account password through the "Profile" page. This page can be easily accessed through the web header located in the top right corner of the SIG-PJ application. Field workers simply need to select the "Profile" menu to access this page. On the "Profile" page, field workers have the option to update their profile information, such as name, email address, phone number, or other relevant details. Additionally, they can change their account password to enhance security. The ability to update the profile and password provides flexibility for field workers to manage their personal information according to their needs. It also ensures that the personal data associated with their account remains up to date and accurate. With the presence of the "Profile" page, field workers can easily manage and update their personal information without needing to contact the admin or any other party. This helps streamline administrative processes and ensures that the information related to field workers' accounts remains current and accurate within the SIG-PJ application.

On the "Profile" page in the SIG-PJ application, field workers have the ability to change certain profile information. However, it should be noted that not all profile information can be changed by the field workers. The information that can be modified includes Name and Phone Number, while the email information cannot be changed. To update profile data such as Name and Phone Number, field workers simply need to fill in the corresponding fields with the new information. After entering the new data, field workers can save the changes by pressing the "Save" or "Update" button available on the "Profile" page. Additionally, if field workers want to change their account password, they must follow the specified steps. The password change process requires the old password as verification, the new password they want to use, and confirmation of the new password to ensure accuracy. Once all the required information has been entered, field workers can save the password changes by pressing the "Save" or "Update" button. With this capability, field workers can manage some of their own profile information without relying on the admin or other parties. This gives them more control over their personal data and enhances the security of their accounts by regularly changing their passwords. This research is consistent with previous studies that state the implementation of Geographic Information Systems (GIS) in the prevention, monitoring, and control of mosquito vectors, particularly diseases such as Dengue Fever, has provided significant benefits in the efforts

to combat and address such health issues. By utilizing web-based GIS technology, healthcare workers and health volunteers can easily gather data on mosquito larvae, analyze their distribution, and take appropriate preventive measures [12,13]. The utilization of GIS technology in mosquito monitoring significantly helps improve the efficiency and accuracy of data collection regarding mosquito populations, mapping their distribution areas, and planning more effective prevention strategies. With the presence of Geographic Information Systems, data related to mosquitoes can be collected, analyzed, and presented in easily understandable visual formats [14,15]. The implementation of Geographic Information Systems in mosquito monitoring, particularly in urban areas, provides more accurate and detailed information about mosquito populations. Through mapping and analysis conducted by GIS, healthcare workers can gain a deeper understanding of mosquito distribution patterns, including the environmental factors that contribute to their spread. With a better understanding of these patterns, appropriate preventive measures can be taken more effectively[16]. Moreover, the utilization of Geographic Information Systems enables healthcare workers to identify areas vulnerable to mosquito-borne diseases. With this information, they can focus on areas that require intervention and allocate resources more efficiently. This assists in planning targeted and effective prevention programs, maximizing efforts to reduce the risk of diseases such as Dengue Fever [17,18]. Overall, the implementation of Geographic Information Systems in the monitoring and control of mosquito vectors, particularly in the case of Dengue Fever, has brought significant benefits in the prevention and control of such diseases. With the assistance of GIS technology, healthcare workers and volunteers can efficiently gather data, accurately analyze mosquito distribution, and plan more effective prevention strategies. Thus, Geographic Information Systems have become an important tool in combating public health issues caused by mosquito vectors.

CONCLUSION

The use of the Geographic Information System and Larvae Monitoring Application (SIG-PJ) has been proven to be more efficient in larvae monitoring surveys conducted by field workers compared to manual methods or the use of Google Form. This application not only provides convenience in questionnaire filling and data collection but also offers additional features such as larvae distribution maps and a dashboard view that facilitates administrators in monitoring and managing the collected data. With the accurate and mappable information provided by the SIG-PJ application system, efforts to prevent Dengue Fever can be carried out more effectively. Furthermore, through a pilot test conducted in Aceh Besar Regency, the application has been tested and proven to be usable by field workers to independently report the number of larvae through online surveys. Thus, the SIG-PJ application has demonstrated its success in enhancing efficiency, providing accurate information, and facilitating larvae monitoring tasks, thereby contributing to the prevention and control of Dengue Fever.

CONFLICT OF INTEREST

The author declares no conflict of interest

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