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# Early Detection and Mapping of Dengue Fever Outbreaks in Urban Areas

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**ABSTRACT**

Dengue Hemorrhagic Fever (DHF) poses a significant public health challenge in tropical regions like Indonesia, where environmental conditions favor the proliferation of Aedes aegypti mosquitoes. The Karya Maju Health Center, serving eight villages in South Sumatra, struggles with monitoring dengue cases due to manual data recording and limited tools for analyzing outbreak patterns. This study aims to address these challenges by developing a system for early detection and mapping of dengue outbreaks. The methodology employs Unified Modeling Language (UML) diagrams, including use case, activity, and class diagrams, to design an intuitive, user-centered system. Use case diagrams outline interactions between healthcare staff and the system, while activity diagrams map the process flow from data collection to visualization. The interface design prioritizes usability, providing stakeholders with clear and accessible tools for monitoring outbreaks. The system was evaluated through pilot testing, which confirmed its ability to meet all predefined criteria. Users found the interface intuitive, with well-structured menus and visualizations facilitating efficient interaction and data analysis. This study contributes to public health by offering a scalable and effective tool for dengue monitoring, enabling healthcare providers to proactively manage outbreaks and allocate resources more effectively.



## 1. Introduction

Dengue Hemorrhagic Fever (DHF) is a mosquito-borne infectious disease caused by the dengue virus, primarily transmitted through the bite of the Aedes aegypti mosquito. It poses a significant public health challenge in many tropical regions, including Indonesia [1]-[5]. With its rapid transmission and potential to cause severe complications if not promptly treated, DHF remains a serious concern. The number of DHF cases in Indonesia continues to rise yearly, particularly during the rainy season. The humid environment and standing water during this period create ideal breeding conditions for mosquitoes, exacerbating the problem. Currently, there is no specific treatment for dengue fever, making it a critical public health issue requiring focused attention.

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The Karya Maju Health Center, established in May 1985, serves as a primary healthcare facility located on Jalan Nusantara in Karya Maju Village, Keluang District, Musi Banyuasin Regency, South Sumatra. As the main healthcare provider for eight surrounding villages, the health center plays a vital role in the prevention and management of infectious diseases, including DHF. However, the health center faces challenges in monitoring the spread of dengue fever cases due to its reliance on manual data recording. The dynamic nature of dengue's spread is evident in the shifting patterns of affected areas, which often move between the villages under the health center's jurisdiction. Without adequate tools to analyze and visualize case distribution, the center's efforts in prevention and response remain suboptimal. A mapping system could transform this process, providing a more structured and effective way to monitor and address dengue fever outbreaks. Such a system would not only enhance the health center's ability to identify high-risk areas but also improve the overall management of DHF cases in the region.

## 2. Method

This study employs a structured methodology to develop a system for the early detection and mapping of dengue fever outbreaks in urban areas. The system design process incorporates the use of UML diagrams to ensure clarity and efficiency in development [6]-[10]. Use case diagrams were created to map the interactions between users—such as healthcare workers, public health officials, and system administrators—and the system, highlighting their roles in data input, outbreak monitoring, and visualization. Activity diagrams were utilized to illustrate the sequence of processes, from collecting and analyzing environmental and case data to generating real-time outbreak maps [11]-[15]. The interface design focuses on user-friendliness, with intuitive menus and visualizations that make it easy for stakeholders to access and interpret critical information. This methodical approach ensures the system is not only effective in detecting and mapping dengue outbreaks but also practical and accessible for its intended users.

## 3. Result and Discussion

We utilized the Unified Modeling Language (UML) to model the system design comprehensively. The design includes use case diagrams to illustrate interactions between users and the system, activity diagrams to depict the flow of activities within the system, and class diagrams to define the structure of the system by specifying the classes to be developed. These diagrams (Table 1 – Table 3) collectively address key technological aspects, encompassing data, processes, and system interfaces.

**Table 1.** The society use case

| No | Name of use case | Description |
|---|---|---|
| 1 | Maps | In this use case, actors can see the distribution of DHF cases in the form of a map. |
| 2 | Patiens chart | The actor can see a chart of the number of DHF patients. |
| 3 | FAQ | Actors can view a list of frequently asked questions and their answers regarding the system, health centers, and dengue fever handling. |
| 4 | DHF Information | Actors can view data and statistical information regarding the number of dengue fever cases, vulnerable villages, total population, number of villages and detailed information on each village. |

**Table 2.** The admin use case

| No | Name of use case | Description |
|---|---|---|
| 1 | Login | Actors are required to enter a username and password to be able to enter the home page (dashboard). |
| 2 | Manage patients | Actors can manage DBD patient data, including adding, editing, deleting patient data. |
| 3 | Manage Villages | Actors can manage village data in the Karya Maju health center work area, including adding, editing, deleting village data. |
| 4 | Manage DHF Information | Actors can manage detailed statistical data and information related to DHF cases in the health center's work area. Management includes adding, editing, and deleting data, which includes the number of DHF cases, vulnerable villages, total population, number of villages, and detailed information for each village. |
| 5 | Maps | Actors can see the distribution of DHF cases in the form of a map. |
| 6 | Patiens chart | Actors can see the chart of the number of dengue fever patients. |

**Table 3.** The head of health center

| No | Name of use case | Description |
|---|---|---|
| 1 | Login | Actors are required to enter a username and password to be able to enter the home page (dashboard). |
| 2 | Number of dengue fever patients | The actor gets a notification if the number of patients exceeds the limit. |
| 3 | Patiens chart | Actors can view a chart of the number of dengue patients. |
| 4 | Villages Info | Actors can view village data in the health center's work area |
| 5 | Patiens Info | Actors can view DHF patient data, such as name, address, date of birth, etc. |
| 6 | Maps | actors can see the distribution of dengue cases on the map. |
| 7 | DHF info | Actors can view data and statistical information regarding the number of DHF cases, vulnerable villages, total population, number of villages and detailed information on each village. |

| | | |
|---|---|---|
| 8 | Report | Actors can make reports such as the implementation of fogging for the health department if the number of patients exceeds the limit. |

Some examples of the proposed system interfaces are shown in Figure 1 - Figure 4 as follows:


**Figure 1** – Admin dashboard


**Figure 2** – Manage villages

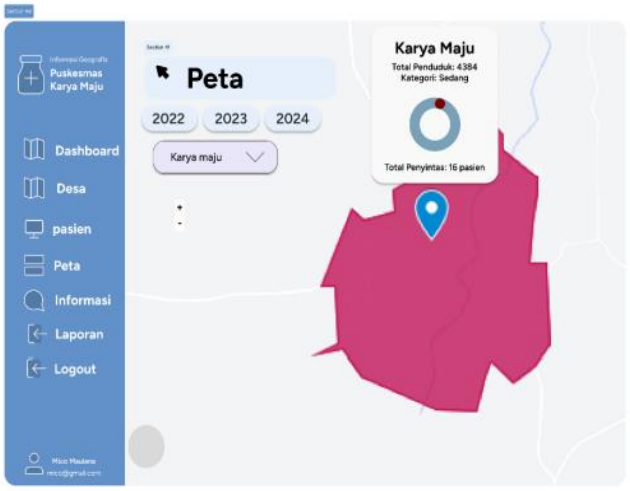


**Figure 3** – DHF cases map

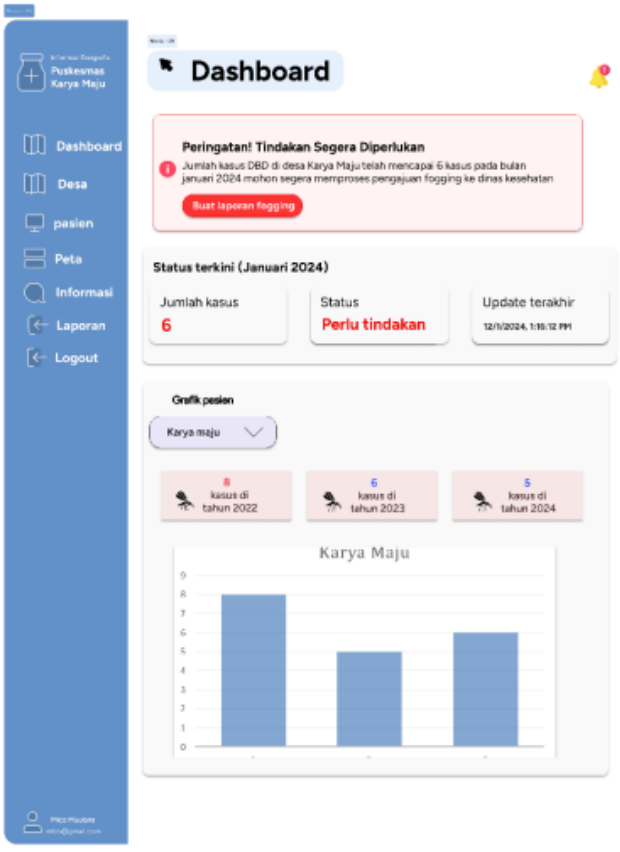


**Figure 4** – The head of health center dashboard

The pilot test results reveal that the proposed system design aligns well with all predefined assessment criteria, showcasing its effectiveness and functionality. The system's interface, including its menus, forms, and buttons, has been thoughtfully designed to ensure clarity and accessibility. This makes navigation straightforward and reduces the learning curve for users, enabling them to interact with the system effortlessly. The design elements demonstrate a strong emphasis on usability,

ensuring that users can complete tasks efficiently and without confusion. Furthermore, the information displayed on the system pages is well-structured and easy to comprehend. Clear labeling and consistent formatting contribute to an intuitive user experience, allowing users to quickly locate the features or data they need. These findings highlight the success of the design in creating a user-centered system that not only meets technical requirements but also enhances overall satisfaction and ease of use.

## 5. Conclusion

The development of an early detection and mapping system for dengue fever outbreaks represents a significant advancement in public health management, particularly for regions like Karya Maju Village and its surrounding areas. By leveraging a structured design approach using UML diagrams, the system provides a robust framework for monitoring and responding to dengue cases. The inclusion of intuitive interfaces and interactive features ensures that stakeholders, including health center staff and administrators, can efficiently manage and visualize outbreak data. The pilot test results affirm the system's effectiveness, demonstrating its ability to meet assessment criteria while offering a user-friendly experience. This system not only empowers healthcare providers with actionable insights but also lays the groundwork for more proactive and informed decision-making in combating dengue fever outbreaks in urban areas.

## REFERENCES


[1] M. Kanan *et al.*, "Genetic variants associated with dengue hemorrhagic fever. A systematic review and meta-analysis," *J. Infect. Public Health*, vol. 17, no. 4, pp. 579–587, 2024, doi: 10.1016/j.jiph.2024.02.001.

[2] A. A. Alshehri and A. A. Irekeola, "Global prevalence of alkhumra hemorrhagic fever virus infection: The first meta-analysis and systematic review," *J. Infect. Public Health*, vol. 17, no. 6, pp. 986–993, 2024, doi: 10.1016/j.jiph.2024.04.001.

[3] Y. Choi and Y. Kim, "Application of multiplex realtime PCR detection for hemorrhagic fever syndrome viruses," *J. Infect. Public Health*, vol. 16, no. 12, pp. 1933–1941, 2023, doi: 10.1016/j.jiph.2023.10.012.

[4] X. Liu *et al.*, "A rapid and visual detection method for Crimean-Congo hemorrhagic fever virus by targeting S gene," *J. Integr. Agric.*, vol. 23, no. 6, pp. 2149–2153, 2024, doi: 10.1016/j.jia.2024.03.050.

[5] B. Coler *et al.*, "Common pathways targeted by viral hemorrhagic fever viruses to infect the placenta and increase the risk of stillbirth," *Placenta*, vol. 141, no. June 2022, pp. 2–9, 2023, doi: 10.1016/j.placenta.2022.10.002.

[6] G. Bergström *et al.*, "Evaluating the layout quality of UML class diagrams using machine learning," *J. Syst. Softw.*, vol. 192, p. 111413, 2022, doi: 10.1016/j.jss.2022.111413.

[7] Y. Numa and A. Ohnishi, "Supporting change management of UML class diagrams," *Procedia Comput. Sci.*, vol. 225, pp. 208–217, 2023, doi: 10.1016/j.procs.2023.10.005.

[8] H. Wu, "QMaxUSE: A new tool for verifying UML class diagrams and OCL invariants," *Sci. Comput. Program.*, vol. 228, p. 102955, 2023, doi: 10.1016/j.scico.2023.102955.

[9] M. Thomas, I. Mihaela, R. M. Andrianjaka, D. W. Germain, and I. Sorin, "Metamodel based approach to generate user interface mockup from UML class diagram," *Procedia Comput. Sci.*, vol. 184, pp. 779–784, 2021, doi: 10.1016/j.procs.2021.03.096.

[10] D. Rosca and L. Domingues, "A systematic comparison of roundtrip software engineering approaches applied to UML class diagram," *Procedia Comput. Sci.*, vol. 181, no. 2019, pp. 861–868, 2021, doi: 10.1016/j.procs.2021.01.240.

[11] A. Voorman, K. O. Reilly, H. Lyons, A. Kumar, K. Touray, and S. Okiror, "Real-time prediction model of cVDPV2 outbreaks to aid outbreak response vaccination strategies q," *Vaccine*, vol. 41, pp. A105–A112, 2023, doi: 10.1016/j.vaccine.2021.08.064.

[12] P. Li *et al.*, "Rapid identification and metagenomics analysis of the adenovirus type 55 outbreak in Hubei using real-time and high-throughput sequencing platforms," *Infect. Genet. Evol.*, vol. 93, p. 104939, 2021, doi: 10.1016/j.meegid.2021.104939.

[13] M. Moore, H. Robertson, D. Rosado, E. Graeden, C. J. Carlson, and R. Katz, "SSM - Health Systems Core components of infectious disease outbreak response," *SSM - Heal. Syst.*, vol. 3, no. September, p. 100030, 2024, doi: 10.1016/j.ssmhs.2024.100030.

[14] R. Traynor *et al.*, "Successful control of an outbreak of Panton–Valentine leucocidin positive meticillin resistant Staphylococcus aureus in a National Burns Unit through early detection by whole genome sequencing," *Infect. Prev. Pract.*, vol. 6, no. 4, p. 100400, 2024, doi: 10.1016/j.infpip.2024.100400.

[15] D. I. Fallatah and H. A. Adekola, "Digital epidemiology: harnessing big data for early detection and monitoring of viral outbreaks," *Infect. Prev. Pract.*, vol. 6, no. 3, p. 100382, 2024, doi: 10.1016/j.infpip.2024.100382.