Global Research Network Publishing
TECHNOVATE: Journal of Information Technology and Strategic Innovation Management
Vol 2, No 2, April 2025, pp.104-111
e-ISSN: 3047-2466

Digital Information System for Mapping Health Crisis Response Capacity in Bali Province

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ARTICLE INFO

Article History:
Received 20 April 2025
Revised 20 May 2025
Accepted 24 June 2025

Keywords:
Information Systems; Response Map; Health Crisis

ABSTRACT

The Bali Provincial Health Office is currently mapping disaster locations and health facility capacities in and around affected areas using analog maps. However, these maps have several limitations that slow down officers in preparing the necessary information required by leadership for decision-making in health crisis management. Therefore, a digital mapping system is urgently needed to facilitate and accelerate the compilation of information, enabling quick and efficient decision-making. This study employed data collection methods through interviews and visual observations. The outcome is a capacity mapping information system that supports the Health Office in managing disaster and health crisis responses by integrating disaster maps and health service capacities. System testing was conducted 32 times using the Black Box Testing method, with standards based on predefined testing scenarios.

1. Introduction

A health crisis occurs when an event or series of events causes human casualties and the capacity of health resources is unable to cope with these conditions. During this period, quick decisions are needed from the leadership in an effort to save victims so that the impact on victims can be minimized or even no impact. In accordance with the vision of the Bali Provincial Government, namely Nangun Sat Kerthi Loka Bali(Mahendra, 2021; Muku et al., 2025) which is further contained in 22 missions, the third mission clearly states that developing affordable, equitable, fair and quality public health services and supported by the development of a sub-district-based Krama Bali health history system and database. The mission implies that all Krama Bali must obtain health services equally and fairly in all situations including disaster situations. Although in disaster conditions the quality of health services provided cannot be ignored. Nationally, the priority programs of the Ministry of Health are contained in 6 pillars of health transformation. The third pillar is the transformation of the health resilience system which includes strengthening emergency response resilience by conducting a national surveillance network, preparing emergency response reserve personnel.

Disasters can be caused by natural disasters, non-natural disasters including outbreaks/pandemics and social disasters. Based on the Bali Province Disaster Risk Assessment document in 2022 there are 14 types of disasters that have the potential to occur in Bali Province with an increase in disasters occurring every year. In 2023 the health facilities owned in Bali Province include 75 hospitals, 120 puskesmas, 252 clinics, 9 Public Safety Centers in 9 districts / cities and Province. But this data is not enough to know the health capacity, especially during disaster emergency response. And one more type of disaster to watch out for is infectious disease disasters (outbreaks / pandemics) such as those recently passed, namely the Covid19 pandemic. The Covid-19 pandemic is a global health

problem that impacts health services around the world(Lal et al., 2022) . At the national level, the pandemic resulted in massive innovation and change and fundamentally changed all existing systems and arrangements to a new way of health system resilience in the country. Health resilience is a shared responsibility between the government, community, academia, business and media. The Ministries and Institutions involved, including local governments are expected to take steps in a coordinated and integrated manner according to their respective duties, functions and authorities in an effort to improve the ability to manage various health crisis threats in an integrated manner .(A. Budiman et al., 2021)

To facilitate the tasks and functions of the health cluster, after a series of discussions and analyzing various existing literature, a unit within the Provincial Health Office called the Health Crisis Control Center / HEOC and a website application called the Health Crisis Control Center Capacity Map Information System. During the emergency response period HEOC is activated and has a very strategic role in helping leaders quickly decide on policies and actions in responding to a health crisis event. One of the challenges in the Covid-19 response is that the command and coordination system in the health sector is not optimal. The reasons include the inactivation of the health cluster system so that each subsystem has not carried out its functions in an integrated manner.

The Bali Provincial Health Office in terms of handling the health crisis, namely in the process of mapping the location of the disaster and the capacity of health facilities at the location and around the affected locations, uses an analog map which has several disadvantages, namely a long time to prepare a response map and requires limited space, thus slowing down officers in preparing every need needed by the leadership in making decisions to overcome the health crisis(Avvenuti et al., 2018; Durski et al., 2020) . Therefore, the digital map system(D. Budiman et al., 2024; Fairuzabadi et al., 2023; Smallwood et al., 2025) is needed by the Bali Provincial Health Office to help simplify and speed up the process of preparing information that will be submitted to leaders to make quick and efficient decisions. So it is necessary to create a website application for the Health Crisis Control Center Capacity Map Information System in Bali Province.

2. Literature Review

A comprehensive understanding of response capacity is essential for effective health crisis management. Capacity encompasses human resources, medical equipment, infrastructure, logistics, and coordination mechanisms. Frameworks such as the WHO Health Emergency and Disaster Risk Management (H-EDRM) and the Sendai Framework emphasize interoperable information systems to ensure timely and evidence-based decision-making. Digital systems serve as the backbone of crisis governance by integrating fragmented data into actionable insights for resource allocation (Durski et al., 2020).

During COVID-19, many low- and middle-income countries revealed limitations in their health information infrastructures, which were largely designed for routine reporting rather than fast-moving crises. Platforms like DHIS2, Go.Data, SORMAS, and WHO's HeRAMS helped capture resource availability (Devasia et al., 2020; Lal et al., 2022), but challenges persisted, including data silos, inconsistent indicators, and limited sub-provincial detail. Geospatial Information Systems (GIS) and Spatial Decision Support Systems (SDSS) enhanced visualization by linking facility capacity with population, mobility, and hazard data (Cahyanto et al., 2022; Nurarifah & Kuntadi, 2024; Pratistha et al., 2022; Riani et al., 2024; Sarasvananda et al., 2022). In contexts like Bali, with unique geographic and tourism pressures, these tools are particularly relevant.

Interoperability remains a key determinant of success. OpenHIE architecture, HL7 FHIR, and facility registries enable data exchange across electronic medical records, logistics, and incident management systems (Santosa et al., 2024; Saputro et al., 2024). Offline-capable mobile tools ensure continuity where connectivity is weak. Privacy compliance and secure data governance are critical to maintain trust and usability (Smallwood et al., 2025).

From an analytics perspective, capacity mapping requires structural, process, and outcome indicators. Automated monitoring and machine-assisted analytics can improve timeliness and accuracy (Avvenuti et al., 2018; Kwintiana et al., 2023; Wiguna et al., 2022), while user-centered design ensures information is delivered in an accessible, actionable format. Dashboards must balance

simplicity and depth, offering progressive drill-downs and tailored views for diverse users, from crisis managers to logistics officers.

Sustainability is another challenge. Many emergency dashboards launched during the pandemic were temporary and poorly integrated into routine systems. Best practices now recommend embedding crisis modules into existing infrastructures, with institutionalized governance, budget allocation, and training for long-term viability.

For Bali Province, the literature suggests combining resource inventory with SDSS to address infectious disease and multi-hazard contexts. Integration with national and private sector platforms is essential for comprehensive coverage. Equity analysis, automated data quality checks, and modular open-standard design are recommended to strengthen preparedness and ensure system adaptability. In summary, the literature converges on the need for interoperable, geospatial, and user-centered digital systems that transform multi-source data into reliable decision-making tools, positioning Bali Province to build a sustainable and resilient health crisis capacity mapping system.

3. Research Methods

This research applies the DevOps approach in designing the Health Crisis Control Center Capacity Map Information System. The selection of the DevOps method is based on its nature that integrates aspects of development and operations, thus allowing the application development process to take place iteratively and adaptively to user needs.(Gunawan et al., 2024; Hidayat et al., 2024; Kherismawati et al., 2025) . In addition, DevOps encourages synergy between the development team and relevant stakeholders, so that the resulting application not only meets expectations, but is also ready to be implemented effectively.

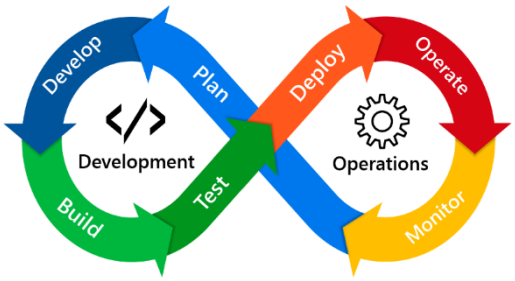

Fig.1. DevOps Method Flow

Referring to Figure 1, the initial stage of the process begins with planning to identify the functional and non-functional needs of the system, with an emphasis on the needs of the Health Crisis Control Center Capacity Map Information System. The next stage is development, which includes interface design and implementation of the web-based application, with continuous evaluation. Repeated trials were applied to ensure system performance and security were maintained.(Legito et al., 2023; Sudipa et al., 2023; Yanti et al., 2023) . Once the application was deemed stable enough, a gradual deployment process was carried out to minimize risks, accompanied by performance monitoring and collection of user feedback. This mechanism supports the process of improving the application through continuous updates to keep it relevant to the needs. By applying DevOps, this research seeks to produce an information system that not only meets technical standards, but is also able to ensure the sustainability of its use through a collaborative and adaptive development approach.

Data Collection Technique

The data collection process uses interview techniques to obtain data The information obtained is in the form of a health crisis management flow. From the results of the interview obtained data in the form of response maps and health capacity data. Furthermore, conducting direct observation techniques at the Bali Provincial Health Office by observing the flow of handling health crisis

management. By making direct observations in the process of overcoming the health crisis at the Bali Provincial Health Office, researchers found problems that often occur, namely when mapping the capacity of health facilities is done manually, namely using paper and pins to put information at the point of health facilities around the disaster site. This causes health crisis management to be less efficient.

4. Results and Discussions

Analysis of System Feature Requirement

The information system of the health crisis control center capacity map at the Bali Provincial Health Office contains the processing of health crisis capacity maps, namely to store information on health crisis control map data that will be made by officers and then submitted to leaders to make decisions. This information system produces disaster map reports and the capacity of related health facilities to cope with the health crisis. There are several system feature requirements as follows:

1) View layout
   a. View map layout
   b. Viewing the capacity of health facilities
   c. View user location coordinates
2) Manage Health Facility Data
   a. View Health Facility Data
   b. Add Health Facility Data
   c. Change Health Facility Data
   d. Delete Health Facility Data
   e. Search Health Facility Data
3) Manage Account Data
   a. Change admin password
   b. Change facility password
4) Report
   a. Print Report

System Context Diagram

In this context diagram describes the entire system that has guest, admin and health facility entities that interact with the system.

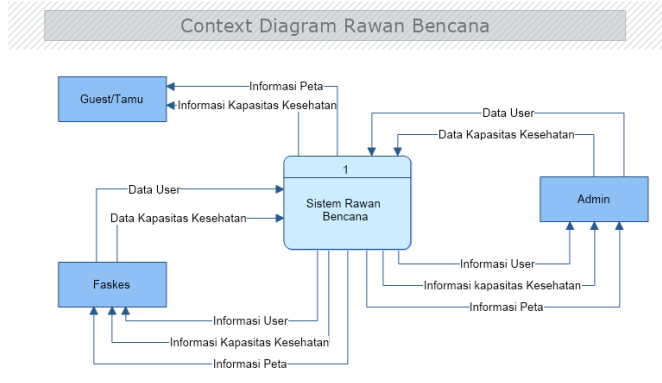

Fig.2. Disaster Prone Context Diagram

System Implementation

On the main page there are several displays such as the main page, dashboard page, health facility details page, and map layout page.

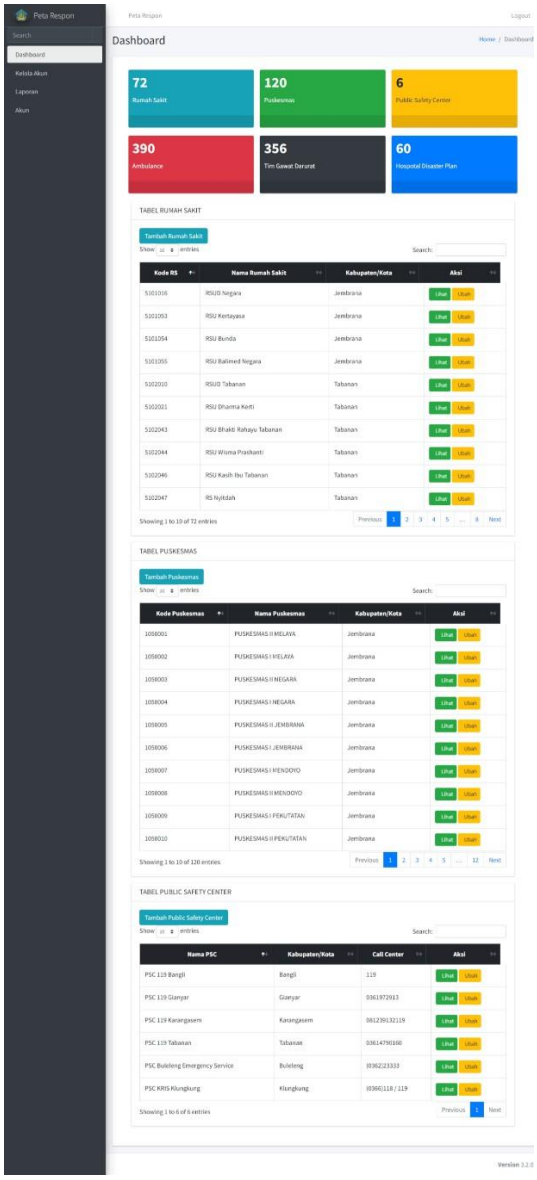

Fig.3. Dashboard Page

Health Facility Detail Page

On this health facility detail page displays information on the currently selected health facility.

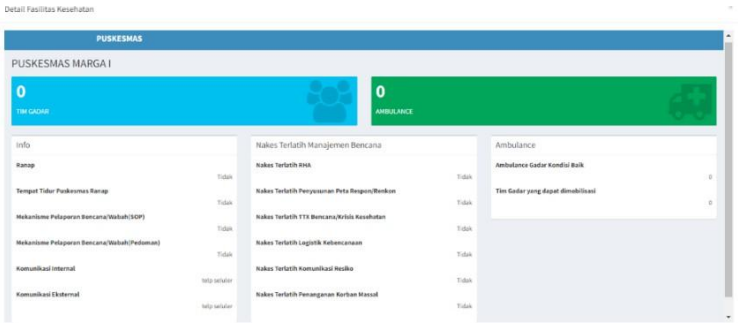

Fig.4. Health Facility Detail Page

Map Layout Page

On this map layout page displays disaster-prone areas and displays the disaster index from lowest to highest.

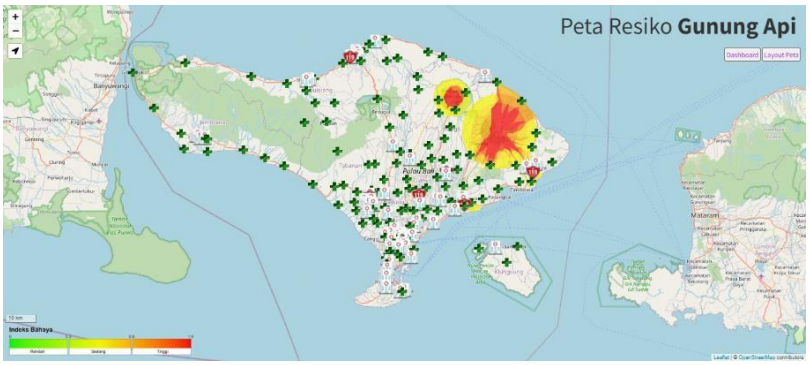

Fig.5. Map Layout Page

Report Page

On the report page the admin can filter the disaster risk map and health facilities, and the admin can print the filter results.

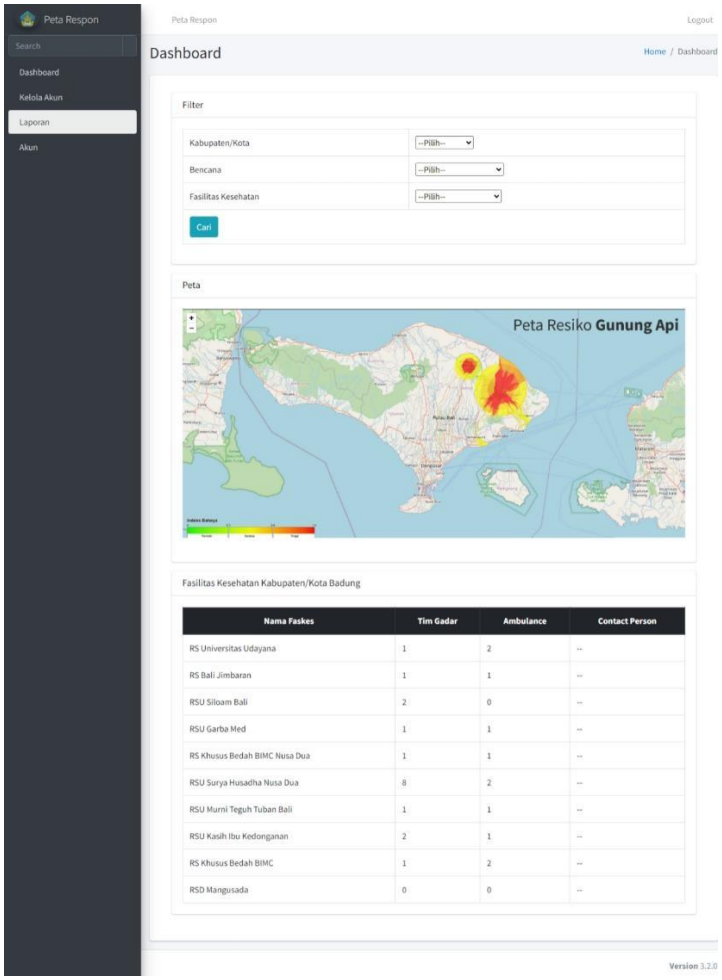

Fig.6. Report Page

5. Conclusion

Based on the analysis of the Health Crisis Control Center Capacity Map Information System at the Bali Provincial Health Office that has been discussed, it can be concluded that: a) The design and development of the Health Crisis Control Center Capacity Map Information System at the Bali Provincial Health Office has been successfully carried out. Every feature in this system is in accordance with the design. Based on the results of blackbox testing 32 times the scenario shows that the system has run according to . In the design of the Health Crisis Control Center Capacity Map Information System at the Bali Provincial Health Office which has been discussed previously, the researchers provide the following suggestions: It is hoped that further system development will be equipped with a disaster report printing feature, so that other supporting health facility accounts such as clinics, laboratories are added.

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