World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

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Sagip Manileño: A mobile emergency response system with SMS-based offline alert capability

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World Journal of Advanced Research and Reviews, 2026, 30(02), 1886-1894

Publication history: Received on 22 April 2026; revised on 21 May 2026; accepted on 23 May 2026

Article DOI: https://doi.org/10.30574/wjarr.2026.30.2.1471

Abstract

Emergency response operations in Manila continue to face significant challenges due to fragmented inter-agency communication, dependence on internet connectivity, and delays in responder coordination. These limitations reduce the effectiveness of emergency management systems, particularly during disasters where communication infrastructure becomes unstable or unavailable. To address these issues, this study developed Sagip Manileño: A Mobile Emergency Response System with SMS-Based Offline Alert Capability, a mobile-based emergency platform designed to support reliable incident reporting, real-time coordination, and offline emergency communication. The study utilized a developmental research design following the Agile Software Development Life Cycle (SDLC) methodology for iterative planning, design, implementation, testing, and refinement. The system integrated Android-based mobile applications, a web-based Emergency Response Unit (ERU) dashboard, centralized database management, GPS-based tracking, real-time notifications, and SMS transmission for offline emergency communication. Results showed that the developed system obtained an overall mean score of 4.62, interpreted as "Excellent," based on ISO/IEC 25010 evaluation involving 20 respondents. Functional testing also confirmed the successful implementation of emergency alert transmission, offline SMS capability, GPS tracking, and smart route navigation features. The findings indicate that the developed system has the potential to improve communication reliability, response efficiency, and emergency coordination under varying network conditions.

Keywords: Emergency Response System; Offline SMS Alert; GPS Tracking; Mobile Application; Agile SDLC; Real-Time Incident Monitoring.

1. Introduction

Emergency response operations in highly urbanized environments continue to face significant challenges related to fragmented inter-agency coordination, communication delays, and transportation congestion. Existing studies emphasize that while mobile technologies improve incident reporting and information dissemination, ineffective coordination mechanisms among emergency agencies still reduce operational efficiency during time-sensitive emergencies [1,2]. In densely populated urban areas, transportation congestion further delays responder mobility and prolongs emergency response time [3]. These conditions highlight the need for emergency response systems capable of supporting reliable communication and coordinated operations under high-demand and infrastructure-constrained environments.

Although recent emergency response platforms have incorporated real-time reporting, centralized monitoring, and location-based services, many systems remain highly dependent on stable internet connectivity for alert transmission and synchronization [4–6]. During disasters and large-scale emergencies, communication infrastructures frequently

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experience congestion, signal degradation, or temporary outages, limiting the reliability of internet-dependent applications. Existing studies report that emergency systems with limited offline functionality often fail to maintain communication continuity during infrastructure disruptions [7,8]. In contrast, SMS-based communication mechanisms remain effective under unstable network conditions and continue to provide reliable emergency information dissemination in low-connectivity environments [9,10]. However, related emergency applications primarily implement isolated functionalities such as reporting, SMS communication, or tracking without integrating offline communication reliability, synchronization continuity, and centralized responder coordination within a unified operational framework [11–14].

To address these limitations, this study developed *Sagip Manileño: A Mobile Emergency Response System with SMS-Based Offline Alert Capability*, a mobile-based emergency management platform designed to support continuous communication under both online and offline conditions. The proposed system implements a hybrid communication architecture that combines API-based real-time transmission with SMS-based alert delivery during internet disruptions. In addition, the platform integrates synchronization mechanisms, responder assignment, incident monitoring, and a centralized Emergency Response Unit (ERU) dashboard to support coordinated emergency response operations. By integrating offline SMS communication and centralized coordination within a unified architecture, the proposed system aims to improve communication reliability, operational continuity, and emergency response efficiency in highly urbanized environments such as Manila City.

2. Materials and Methods

The system was developed using the Agile Software Development Life Cycle (SDLC), which supports iterative development, continuous testing, and continuous system refinement. The Agile approach consisted of planning, design, development, testing, deployment, and feedback phases used to refine the mobile applications, database structure, emergency workflow, and offline communication features.

The developed system consisted of three major components: a citizen mobile application, a responder mobile application, and a web-based Emergency Response Unit (ERU) dashboard. The citizen application allows users to submit emergency alerts with attached GPS coordinates using either internet-based communication or SMS-based offline transmission. The responder application enables emergency personnel to receive incident assignments, utilize smart route navigation through Google Maps SDK integration, navigate to emergency locations, and update response status in real time. The ERU dashboard serves as the centralized monitoring and coordination platform for managing incidents and assigning responders.

The system architecture followed an Input-Process-Output (IPO) framework integrating citizen users, Emergency Response Units (ERUs), responders, centralized databases, GPS services, and offline communication mechanisms.

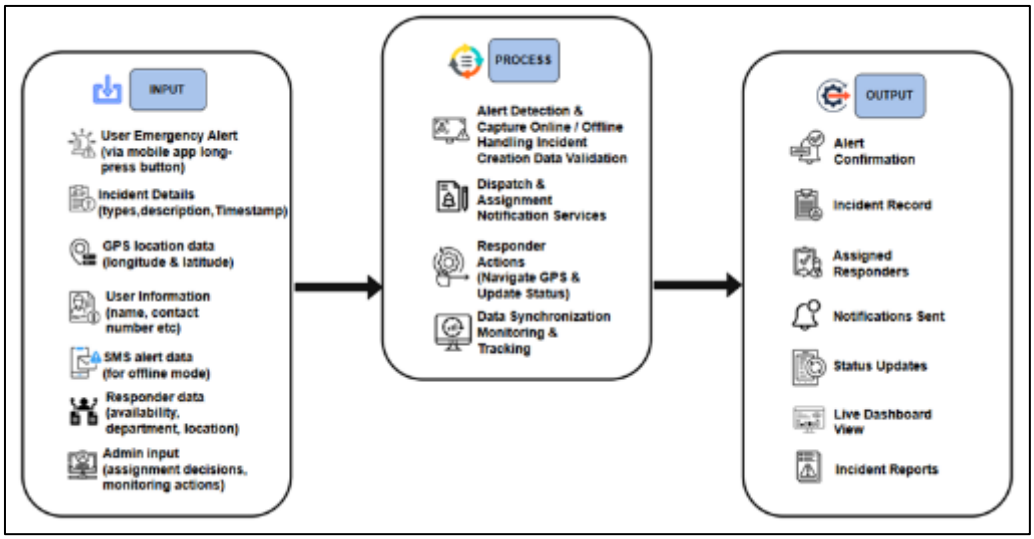

Figure 1 System Architecture of Sagip Manileño

Figure 1 shows that the architecture supports API-based online communication, smart route navigation for responders, and SMS-based offline emergency alert transmission to maintain continuous emergency reporting and responder coordination under varying network conditions.

The system utilized a dual-mode emergency communication workflow wherein emergency alerts were transmitted through API-based communication during online conditions and automatically switched to SMS transmission during internet connectivity interruptions.

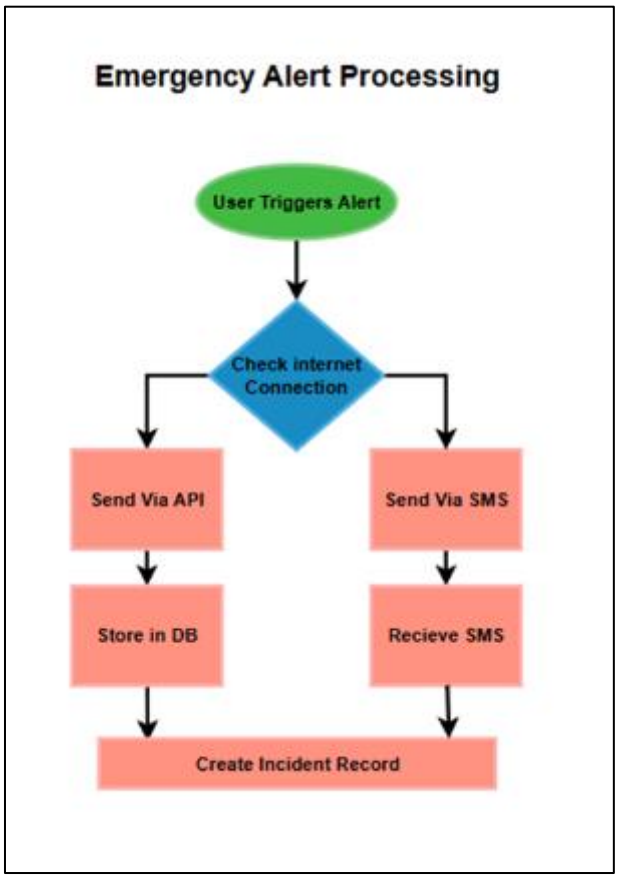

Figure 2 Emergency Alert Processing

Figure 2 shows that the alerts transmitted through SMS were processed by the SMS gateway and converted into structured incident records. Offline alerts were temporarily stored and synchronized with the centralized database once connectivity was restored.

The dataset used in the study consisted of interconnected emergency response records represented through the Incident Table, Incident Assignment Table, and Incident Status Table. The incident table stored emergency details, including incident type, GPS coordinates, report timestamps, source of transmission, and location information. The Incident Assignment Table managed responder allocation and substation assignment, while the Incident Status Table monitored responder activities and real-time emergency status updates.

System evaluation was conducted using selected ISO/IEC 25010 product quality characteristics to assess the functionality, usability, reliability, performance efficiency, and security of the developed emergency response system. Functional testing included emergency alert transmission, offline SMS capability, GPS tracking accuracy, smart route navigation, incident assignment, notification delivery, and dashboard synchronization under both online and offline conditions. Testing was conducted using Android mobile devices under simulated internet-connected and disconnected network environments.

A total of 20 selected respondents, composed of mobile application users and information technology evaluators, participated in the system assessment. Respondents evaluated the system using a structured five-point Likert-scale questionnaire based on selected ISO/IEC 25010 criteria, where 5 represented “Strongly Agree” and 1 represented

"Strongly Disagree." The collected responses were analyzed using weighted mean computation to determine the overall system evaluation and acceptability of the developed application.

3. Results and discussion

The developed system was evaluated through system implementation, functional testing, and ISO/IEC 25010-based respondent assessment to determine its functionality, usability, reliability, performance efficiency, and security.

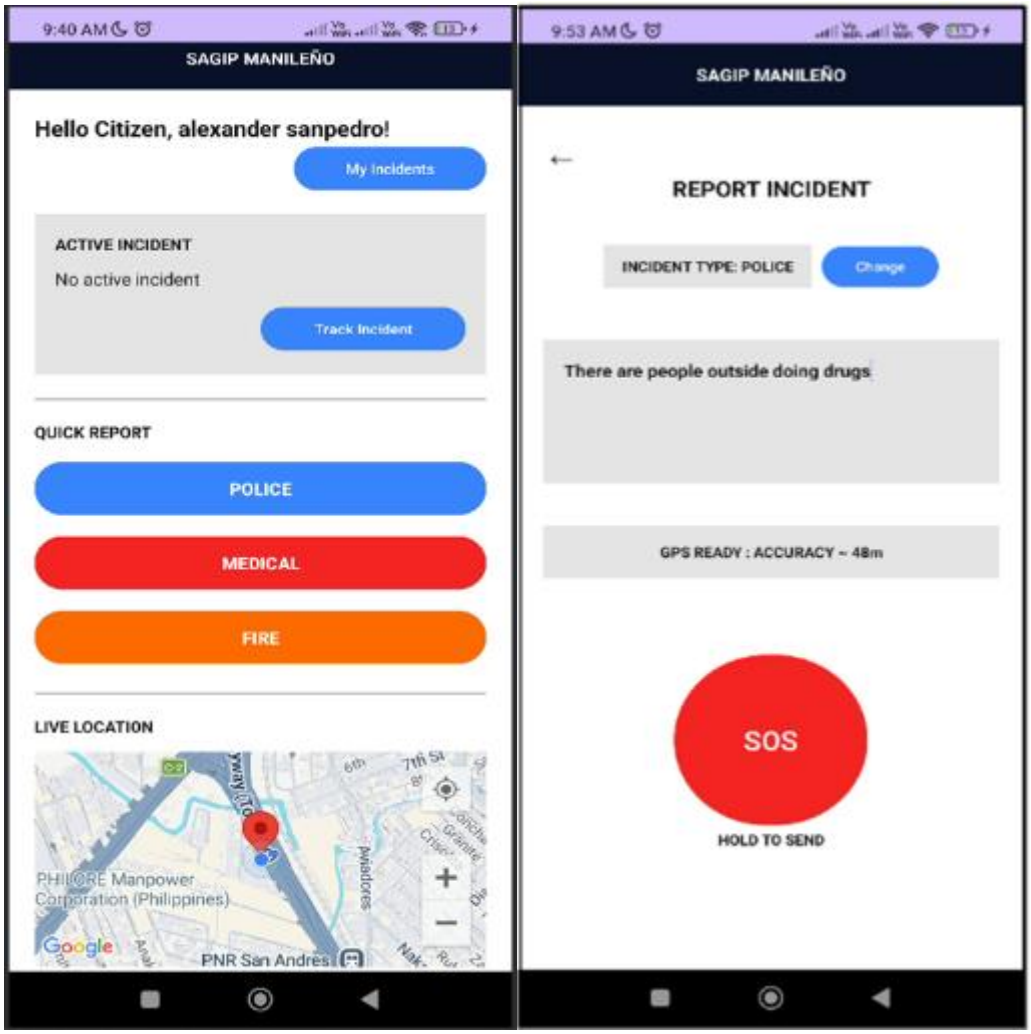

Figure 3 Emergency Alert Reporting Interface

Figure 3 presents the emergency alert reporting interface of the Sagip Manileño mobile application. The developed interface allows users to submit emergency incidents through a centralized platform that integrates communication among emergency response units. Users can provide incident information while location coordinates are automatically captured and attached to the emergency report. The implementation of a unified reporting mechanism improves coordination among responders and minimizes communication fragmentation during emergency situations.

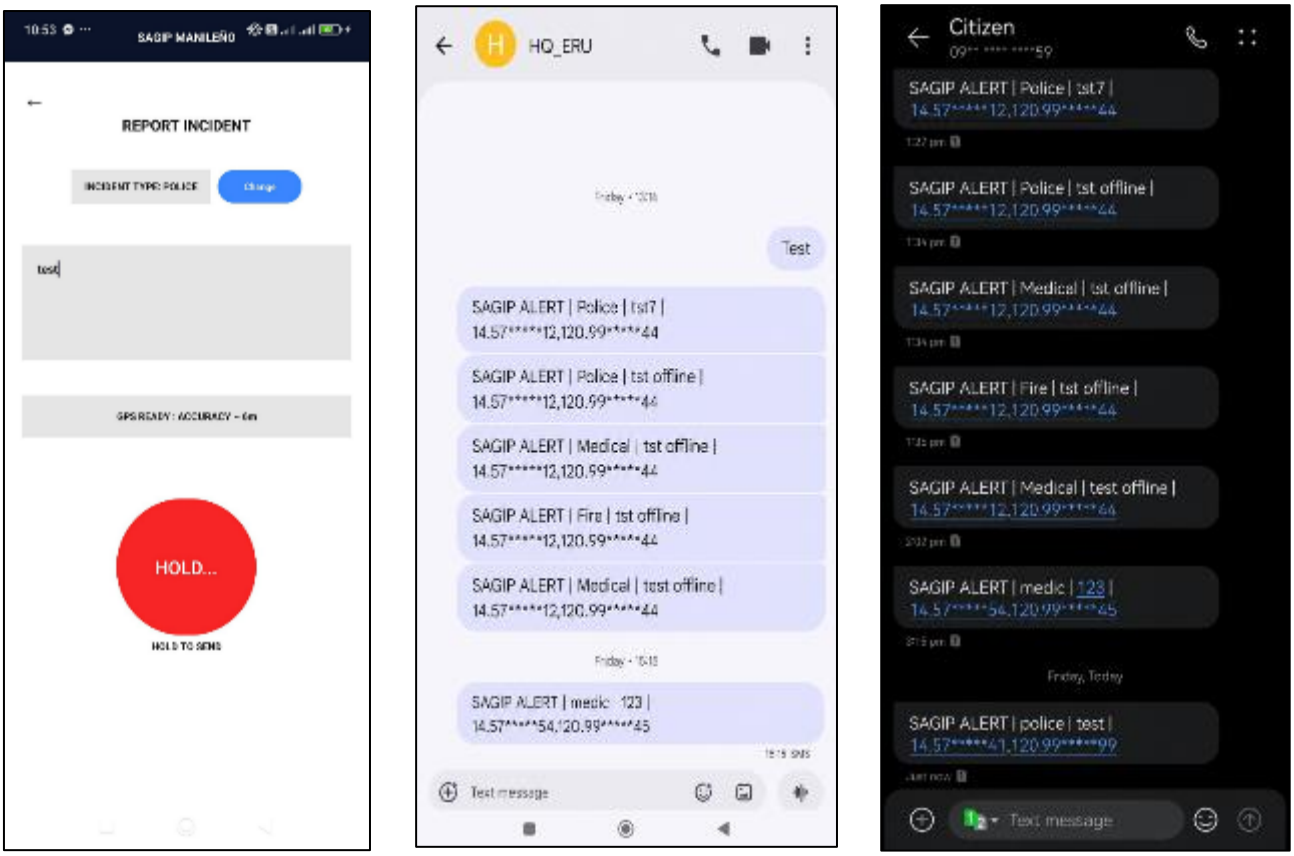

Figure 4 Offline SMS Alert Transmission

Figure 4 illustrates the offline SMS alert capability implemented in the system. When internet connectivity becomes unavailable, the application automatically switches to SMS-based transmission to ensure communication continuity. The implemented feature enables emergency alerts to be transmitted despite internet disruptions, reducing communication failures during emergency scenarios.

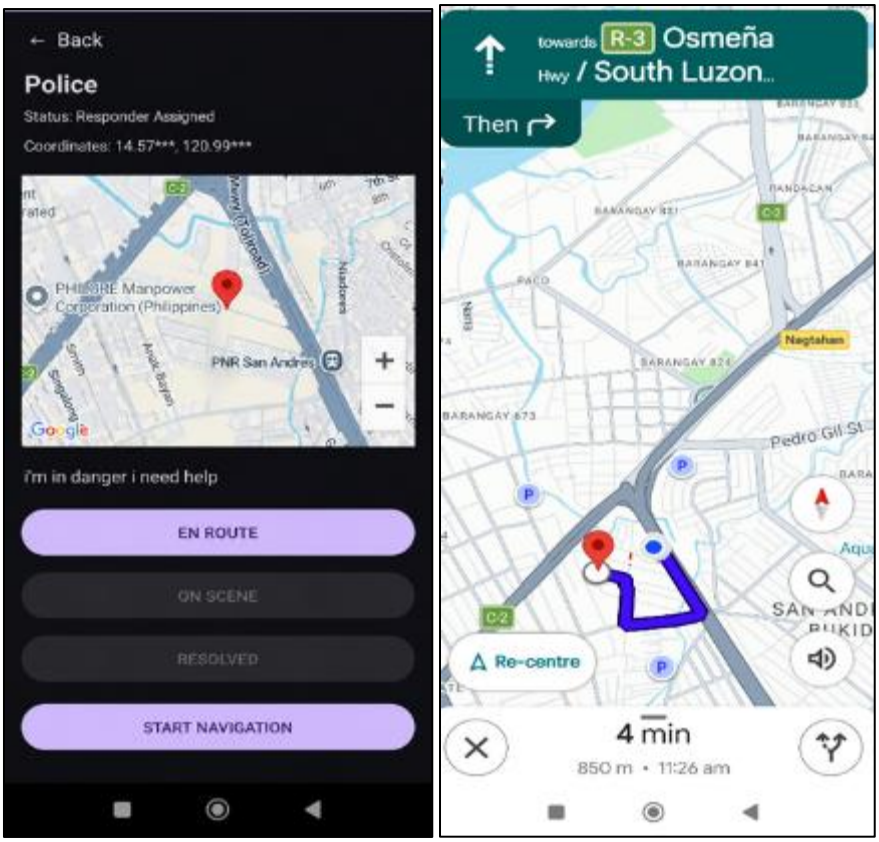

Figure 5 Smart Route Navigation Interface

Figure 5 presents the smart route navigation functionality integrated into the responder application through Google Maps SDK. The feature allows responders to identify incident locations and receive route guidance for faster travel to emergency sites. This functionality improves situational awareness and supports efficient responder dispatch operations.

Functional testing was conducted to evaluate the major features of the developed emergency response system under both online and offline communication conditions. Testing focused on emergency alert transmission, offline SMS functionality, GPS location tracking, smart route navigation, dashboard synchronization, responder assignment, and notification delivery. Results indicated that all core system functions operated successfully during testing.

Table 1 Functional Testing Results

System Function	Description	Result
Online Alert Transmission	Sends emergency alerts through API-based communication	Passed
Offline SMS Alert	Sends emergency alerts through SMS transmission	Passed
GPS Location Tracking	Captures and transmits user location coordinates	Passed
Dashboard Synchronization	Synchronizes incident records with the ERU dashboard	Passed
Responder Assignment	Assigns responders to emergency incidents	Passed
Smart Route Navigation	Provides optimized responder route guidance through Google Maps SDK	Passed
Notification Delivery	Sends real-time emergency notification	Passed

The results demonstrate that the system successfully maintained emergency communication under varying network conditions. The implementation of SMS fallback capability enabled continuous emergency alert transmission even during internet connectivity interruptions. GPS integration and smart route navigation also improved incident location identification, responder route guidance, and coordination during emergency operations.

Respondent evaluation was conducted using selected ISO/IEC 25010 product-quality characteristics involving 20 selected respondents composed of mobile application users and information technology evaluators. The assessment focused on functional suitability, usability, reliability, performance efficiency, and security using a structured Likert-scale questionnaire.

Table 2 ISO/IEC 25010 System Evaluation Results

ISO/IEC 25010 Criteria	Mean	Interpretation
Functional Suitability	4.72	Excellent
Usability	4.65	Excellent
Reliability	4.58	Excellent
Performance Efficiency	4.61	Excellent
Security	4.55	Excellent
Overall Mean	4.62	Excellent

The developed system obtained an overall mean score of 4.62, interpreted as "Excellent," indicating high acceptability among respondents. Functional suitability obtained the highest mean score, suggesting that the developed system effectively met its intended operational requirements, including emergency alert transmission, offline SMS capability, smart route navigation, and responder coordination features. The usability evaluation also indicated that respondents perceived the system interface as accessible and easy to use during emergency reporting activities.

Reliability and performance efficiency results indicated that the system maintained stable operation during testing and responded efficiently during emergency alert processing and synchronization tasks. The security evaluation results suggest that the implemented authentication and database management mechanisms provided acceptable protection for emergency response information.

The findings support previous studies emphasizing the importance of integrating offline communication mechanisms within emergency response systems. Similar to the findings of [8,9], the integration of SMS-based emergency communication supports communication continuity during connectivity disruptions. The integration of GPS tracking, smart route navigation, and real-time centralized monitoring also aligns with previous research highlighting the importance of situational awareness and responder coordination in urban emergency management systems.

4. Conclusion

The findings demonstrate that Sagip Manileño: A Mobile Emergency Response System with SMS-Based Offline Alert Capability effectively supports emergency communication and incident coordination through a hybrid communication architecture operating under both online and offline conditions. The developed system successfully implemented API-based online alert transmission, offline SMS communication, GPS-enabled location tracking, responder assignment, dashboard synchronization, and real-time notification delivery. The system also demonstrated reliable local data persistence and automatic synchronization after connectivity restoration, ensuring continuity and consistency of incident records during network interruptions.

A significant contribution of the study is the implementation of a dual-mode communication framework that integrates internet-based data transmission with SMS fallback mechanisms. Unlike conventional emergency response systems that rely solely on internet connectivity, the proposed architecture dynamically supports emergency alert delivery even during network congestion, signal degradation, or infrastructure failure. Through the integration of offline SMS transmission, local SQLite storage, centralized MySQL synchronization, and real-time API communication, the system maintained uninterrupted emergency reporting and responder coordination across varying connectivity conditions. This hybrid communication approach enhances system fault tolerance, communication reliability, and operational continuity during critical emergency scenarios.

Furthermore, the integration of GPS-based geolocation services and a centralized Emergency Response Unit (ERU) coordination dashboard improved situational awareness, incident monitoring, and responder dispatch efficiency. Overall, the study highlights the effectiveness of combining hybrid communication infrastructures, geolocation

technologies, and centralized coordination frameworks in advancing resilient mobile-based emergency management systems for highly urbanized environments such as Manila City.

Compliance with ethical standards

Acknowledgments

The authors would like to express their sincere gratitude to the Faculty of the Information Technology Department of Jesus Reigns Christian College for their guidance and support throughout the development of this research. The authors also thank the potential end-users whose feedback and insights contributed to improving the system's design and functionality. The authors also extend their appreciation to friends and family members for their encouragement, technical insights, and support throughout the development and testing phases of the Sagip Manileño system.

Disclosure of conflict of interest

The authors declare that there are no financial or non-financial conflicts of interest regarding the publication of this study. The researchers conducted the study independently for academic and research purposes only and did not receive any commercial funding or external influence that could affect the results and findings of the study.

Statement of ethical approval

This study was conducted solely for academic and system development purposes. All information collected during system testing and evaluation activities was handled responsibly and used strictly within the scope of the research. The developed system was implemented in accordance with ethical standards concerning data privacy, confidentiality, and the responsible use of information technology.

Statement of informed consent

Informed consent was obtained from all participants involved in the evaluation and testing phases of the study prior to data collection.

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