Design, Implementation, and Evaluation of a Mobile Application for Real-Time Incident Management in Local Government

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***Abstract*—The increasing occurrence of incidents related to public safety, environmental issues, transportation, and civil defense requires more efficient response mechanisms from local governments. However, the absence of an integrated digital tool makes it difficult to accurately identify the location, timing, and frequency of critical incidents in real time, thereby limiting the response capacity of public institutions. This study aims to design, implement, and evaluate a mobile application for incident management to streamline the reporting process and facilitate timely responses to events reported by citizens. The application was developed using the Agile Scrum methodology. Flutter was employed for mobile application development, while PHP and RESTful APIs were used for backend services, with MySQL handling data storage and incident geolocation. In addition, location-based services and web-based visualization components were incorporated to support monitoring and information access. A pre-experimental research design with a single-group pretest–posttest approach was adopted. The results revealed a 99.26% reduction in incident registration time and a 31.68% decrease in immediate response time. The usability of the proposed application was assessed using the Computer System Usability Questionnaire (CSUQ), administered to 257 participants, showing a high level of user satisfaction. Overall, the findings demonstrate that the developed mobile application significantly improves incident management processes and supports the digital transformation initiatives of local governments.**

***Keywords*—Mobile application; incident management; local government; Agile Scrum; usability evaluation; CSUQ; digital transformation.**

I. Introduction

Public safety has become a major concern in Peru, particularly due to the increasing number of incidents reported in recent years. Between 2020 and 2024, both crime rates and citizens' perceptions of insecurity increased considerably. According to national statistics, the victimization rate rose from 18.2% in 2021 to 27.1% in 2024, while more than 80% of the population perceived insecurity as one of the country's most pressing issues [1]. In response to this situation, approximately 66% of municipalities provide public security services through local patrol units (Serenazgo), involving more than 42,000 officers nationwide [2].

Incident management in local governments extends beyond public safety. Environmental complaints, civil defense emergencies, and traffic-related events also require timely and coordinated responses. The Environmental Assessment and Enforcement Agency (OEFA) reported that more than 6,000 environmental complaints have been processed since 2024 through digital platforms such as SINADA, with many cases originating from local issues including solid waste disposal, wastewater discharges, and noise pollution [3]. Likewise, the National Emergency Operations Center (COEN) reported that more than 5,400 emergencies, including heavy rainfall, landslides, and mudslides, were registered between December 2024 and March 2025 [4]. In many cases, local governments are responsible for managing these situations despite lacking early warning mechanisms, rapid response resources, and adequate systems for documenting emergency events.

Similarly, the National Road Safety Observatory reported more than 86,000 traffic accidents and over 3,000 fatalities in Peru during 2024 [5]. Although municipalities, police departments, and healthcare institutions are involved in responding to these events, the lack of a common incident management platform often results in fragmented information and reduced operational efficiency [6], [7].

Recently, local governments have increasingly adopted digital technologies to modernize administrative processes and strengthen communication with citizens [8]. Mobile government (m-government) initiatives have emerged as an important component of this transformation, enabling public services to be delivered through smartphones and other mobile devices. These technologies facilitate real-time access to information, improve service accessibility, and enhance interactions between citizens and government institutions [9], [10].

Incident management represents a critical process for local governments because it directly affects public safety, environmental protection, civil defense, and urban services. Effective incident management requires rapid reporting, accurate classification, efficient communication among stakeholders, and timely response actions. Nevertheless, many municipalities still rely on manual procedures and isolated information systems, leading to delays in both incident notification and response activities [11], [12]. Experiences from smart city initiatives have demonstrated the importance of digital citizen platforms capable of integrating incident reporting, geolocation, and real-time communication functionalities. Motivated by these needs, this study proposes the design, implementation, and evaluation of a mobile application for real-time incident management in the context of

local governments, aiming to strengthen response and monitoring processes.

The main contributions of this work are threefold. First, a mobile application architecture for local government incident management is proposed, enabling real-time monitoring and coordination among the responsible departments. Second, the proposed solution is implemented and validated in an operational environment. Third, the impact of the application is assessed using quantitative indicators associated with incident registration and response times, as well as through usability evaluation using the Computer System Usability Questionnaire (CSUQ) [19]. The results demonstrate that mobile technologies constitute an effective tool for improving incident management processes and supporting digital transformation initiatives in local governments.

II. Related Work

Several studies have shown that mobile government applications contribute to improving public services when their design prioritizes accessibility, usability, and citizen-centered experiences. Previous research has highlighted that the adoption of mobile solutions by local governments has accelerated due to the growing demand for more efficient and personalized digital services [13]. Digital accessibility has also been identified as a key factor influencing the acceptance and effective use of government applications, particularly those intended to enhance public safety and support diverse groups of citizens [14].

Research on mobile-based incident reporting systems has demonstrated the benefits of integrating features such as image capture, textual descriptions, GPS location, and web-based administrative interfaces. These functionalities facilitate the registration, monitoring, and management of incidents reported by citizens, thereby improving communication between communities and government institutions [15]. Such findings indicate that mobile technologies and integrated management platforms can significantly enhance the efficiency of incident response processes.

Smart city research has further emphasized the role of citizen reporting systems as mechanisms for digital participation. Previous studies have shown that smart city applications enable citizens to report urban issues, collaborate with authorities, and actively contribute to decision-making processes [16]. Citizen participation has been recognized as a key factor in increasing the effectiveness and relevance of urban solutions when properly integrated into planning and management activities [17]. Likewise, sustainable smart city initiatives have demonstrated that citizen engagement directly influences urban sustainability outcomes [18]. Other studies have highlighted that technological solutions for sustainable urban development require not only digital infrastructures but also effective interactions between governments and citizens [19]. Collectively, these findings support the development of mobile applications that extend beyond process automation and strengthen the relationship between citizens and local governments.

In recent years, decentralized incident reporting models have gained increasing attention. A decentralized framework for smart city governance based on community participation was proposed in [20], demonstrating that citizens can act as active sensors by reporting incidents and contributing to urban management. Similarly, the platform presented in [21] incorporates citizen reporting, case tracking, and analytical tools to support decision-making processes. These studies illustrate the transition from conventional incident management approaches toward intelligent and collaborative platforms. From the perspective of digital government, previous research has emphasized that digital public services foster regional innovation ecosystems and support sustainable development processes [7]. In this context, the digitalization of incident registration and management processes can improve institutional efficiency while generating valuable information for public administration.

Several studies investigating mobile government services have identified usability, perceived usefulness, trust, service quality, and citizen satisfaction as key determinants of continuous usage intentions [22], [23]. Consequently, usability has emerged as one of the most important factors influencing the success of mobile applications.

The Computer System Usability Questionnaire (CSUQ), originally proposed in [24], has become one of the most widely used instruments for assessing user satisfaction with computer systems. Subsequent studies have identified usability attributes such as efficiency, learnability, satisfaction, and accessibility as essential quality dimensions of mobile services [25]. Moreover, user-centered redesign approaches have been shown to substantially improve user experience in emergency-oriented mobile applications [26]. To address common usability problems in mobile systems, the MUG-10 framework was introduced in [27], emphasizing the importance of intuitive interfaces and simplified interaction processes. In fact, many mobile applications fail not because of insufficient functionality, but because of poor usability and overly complex interaction mechanisms. In addition, focused usability evaluation approaches have also proven valuable for digital applications aimed at citizen participation and public governance [28].

Regarding technological implementation, Flutter has emerged as a popular cross-platform framework for developing Android and iOS applications using a single codebase. Previous studies have reported that Flutter simplifies mobile application development while enabling highly interactive interfaces and delivering competitive performance [29]. Comparative analyses between Flutter and alternative technologies, such as React Native, have revealed advantages in terms of productivity, visual consistency, and cross-platform capabilities [30]-[32]. These findings support the selection of Flutter as a suitable technology for developing mobile applications aimed at incident management in local government environments.

III. Methodology

A. Research Type and Design

This study is classified as applied research, as it addresses a practical problem associated with incident management in a local government environment. A pre-experimental design based on a single-group pretest–posttest approach was employed to assess the impact of the proposed mobile

application. Table I summarizes the elements of the experimental design.

TABLE I. DESCRIPTION OF THE PRE-EXPERIMENTAL DESIGN

Element	Description
Ge	Experimental group
O1	Measurement conducted before the implementation of the mobile application
X	Mobile application intervention
O2	Measurement conducted after the implementation of the mobile application

B. Study Area

The study was conducted at the Provincial Municipality of Abancay, located in the Apurímac region of Peru. This institution is responsible for managing incidents related to public safety, traffic, civil defense, and environmental issues reported by citizens.

Prior to the implementation of the proposed solution, incident registration and monitoring activities relied on conventional procedures based on manual records and telephone communication. These practices often resulted in delays in response and limited the availability of information required for effective decision-making.

C. Population and Sample

The target population consisted of 47,744 inhabitants of the district of Abancay, ranging in age from 15 to 70 years and representing both urban and rural areas, according to data provided by the National Institute of Statistics and Informatics (INEI). A non-probabilistic purposive sampling strategy was adopted, selecting citizens who reported incidents and members of the local public security service (Serenazgo) responsible for incident response and follow-up activities. The sample size was estimated using the finite population formula, resulting in a total of 267 participants.

D. Mobile Application Development

The mobile application was developed following the Agile Scrum methodology. The development process was organized into four iterative and incremental sprints, each incorporating specific functionalities associated with user management, incident reporting, operational response, and report generation. This approach enabled the continuous delivery of functional increments throughout the development cycle.

The process included requirements elicitation and analysis, Product Backlog creation, and sprint planning activities. Each sprint comprised implementation, functional testing, sprint review, and retrospective phases, facilitating continuous improvement and ensuring the progressive integration of system functionalities.

Fig. 1 presents the Scrum workflow adopted during the development process, illustrating the functionalities implemented in each sprint, the stakeholders involved, and the activities carried out throughout the iterative development cycles.

E. System Architecture

Fig. 2 presents the three-layer architecture implemented for the proposed mobile application. This architecture was designed to separate the user interface, business logic, and data management components, thereby improving maintainability, scalability, and future system expansion.

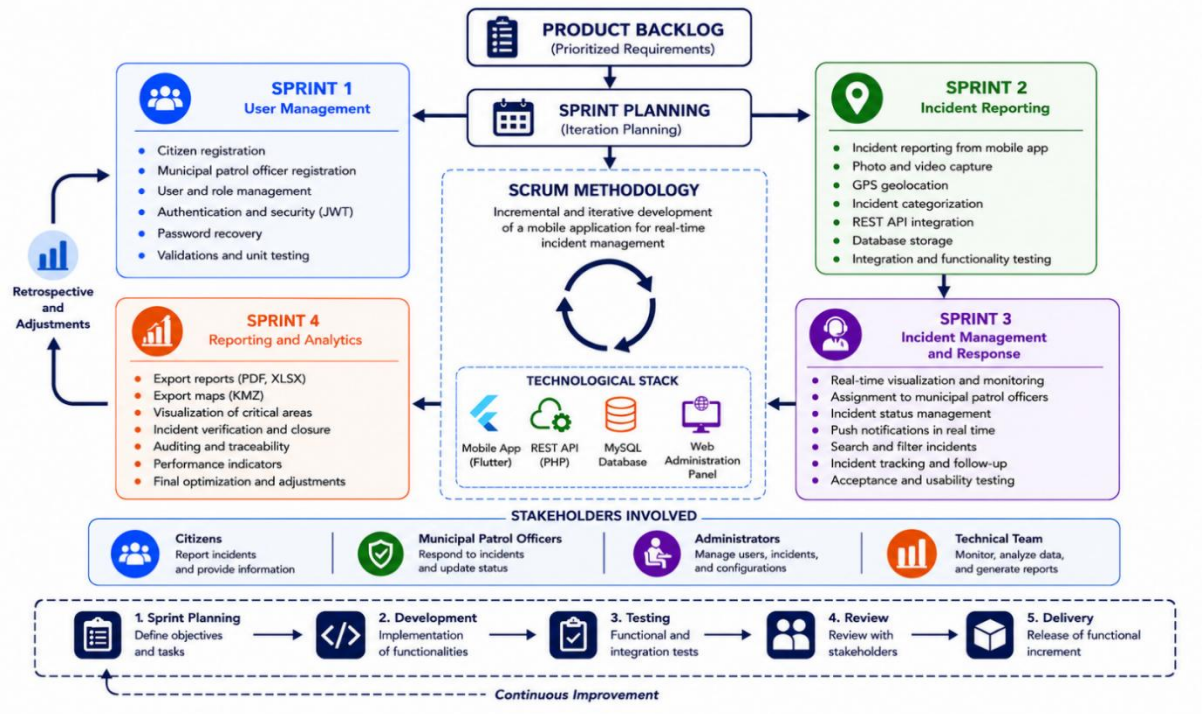


Fig. 1. Scrum-based development process of the proposed real-time incident management mobile application.

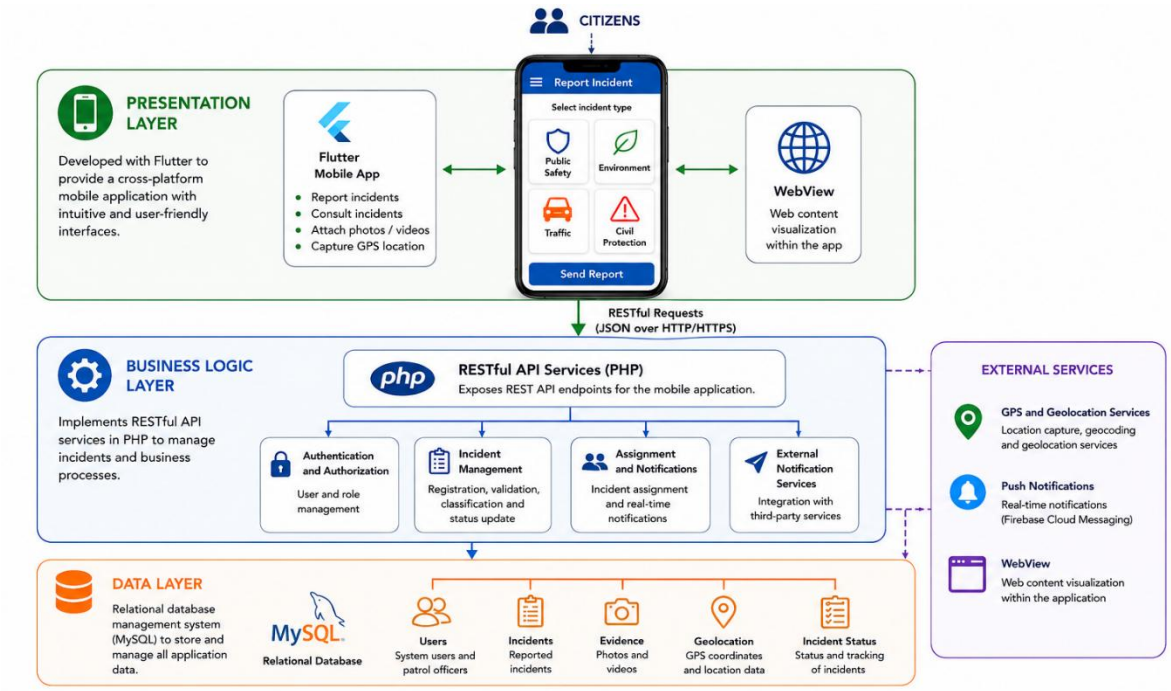


Fig. 2. Three-layer architecture of the proposed mobile application for real-time incident management.

The presentation layer was developed using Flutter to support cross-platform mobile application development. Its main purpose is to allow citizens to report and consult incidents through intuitive and user-friendly interfaces. Through this layer, users can report incidents related to public safety, environmental issues, traffic, and civil defense, including descriptive details, multimedia evidence such as photographs and videos, and GPS-based geographic location data from their mobile devices. WebView was also incorporated to display web content within the application, improving the user experience without requiring users to leave the mobile environment. Communication with the business logic layer is performed through HTTP/HTTPS requests using JSON messages, ensuring efficient and secure interaction between the mobile application and backend services.

The business logic layer was implemented in PHP using a REST API-based architecture, enabling the mobile application to connect with server-side services. This layer manages the incident lifecycle, including registration, validation, classification, assignment, and status updates. REST services were implemented to decouple the mobile application from internal server processes, simplifying maintenance and supporting future platform scalability.

The data layer was implemented using MySQL as the relational database management system. The database was designed to store information related to system users, municipal patrol officers, reported incidents, incident categories, multimedia evidence, service status, geographic coordinates, and geolocation data. The relational structure ensures data integrity and consistency, while also facilitating queries for report generation, performance indicators, and real-time incident monitoring. In addition, geospatial attributes were incorporated to analyze the geographic distribution of incidents and identify critical areas within the municipal jurisdiction.

F. Incident Reporting and Response Workflow

Fig. 3 illustrates the operational workflow implemented by the proposed mobile application for real-time incident management. The process begins when a user logs into the application and completes the authentication procedure. After successful authentication, the user selects the appropriate incident category, including public safety, environmental issues, traffic, or civil protection.

Once the incident type has been selected, the user submits the corresponding information by providing a detailed description, multimedia evidence in the form of photographs or videos, and the geographic location obtained from the mobile device's GPS services. The system then validates the collected information to ensure that all mandatory fields have been completed. If incomplete or invalid information is detected, an error message is displayed, and the user is prompted to provide the missing data before continuing.

After successful validation, the incident report is transmitted to the server and stored in the MySQL database. Based on the incident category, the system automatically assigns the case to the corresponding municipal department or responsible personnel. Real-time notifications are then delivered to authorized staff members, enabling them to initiate response actions promptly.

During the response phase, incident managers update the status of each case within the system. The incident status progresses through different stages, namely pending, in progress, and resolved. These updates are continuously synchronized with the mobile application, allowing citizens to monitor the evolution of their reports and receive real-time information regarding the current status of the incident.

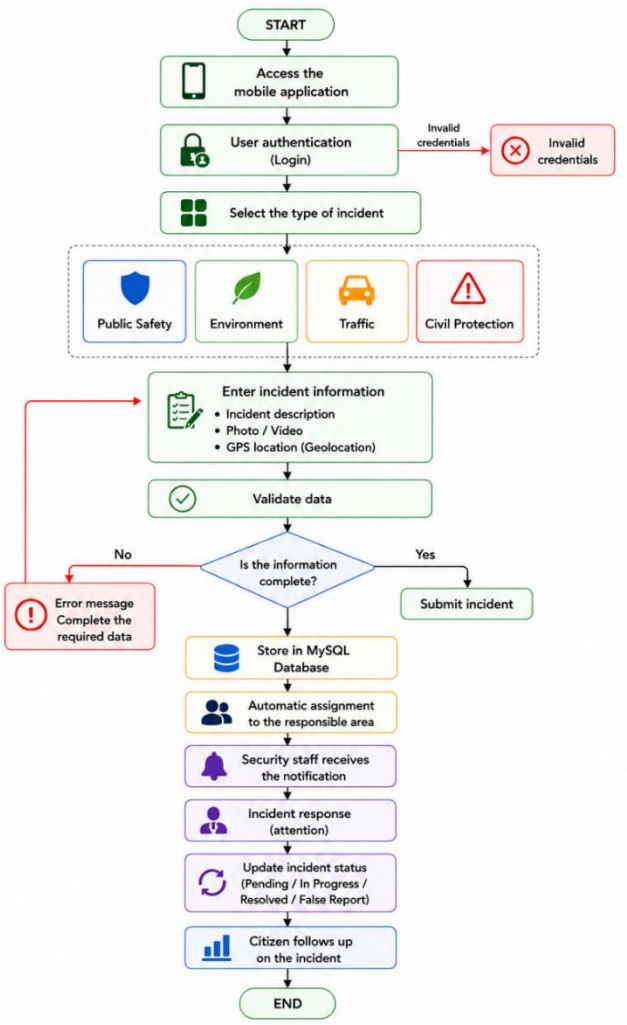


Fig. 3. Incident reporting and response process supported by the proposed mobile application.

Overall, this workflow facilitates efficient interaction between citizens and municipal authorities, improving response times, ensuring traceability of actions, and providing continuous monitoring throughout the incident lifecycle.

G. System Implementation

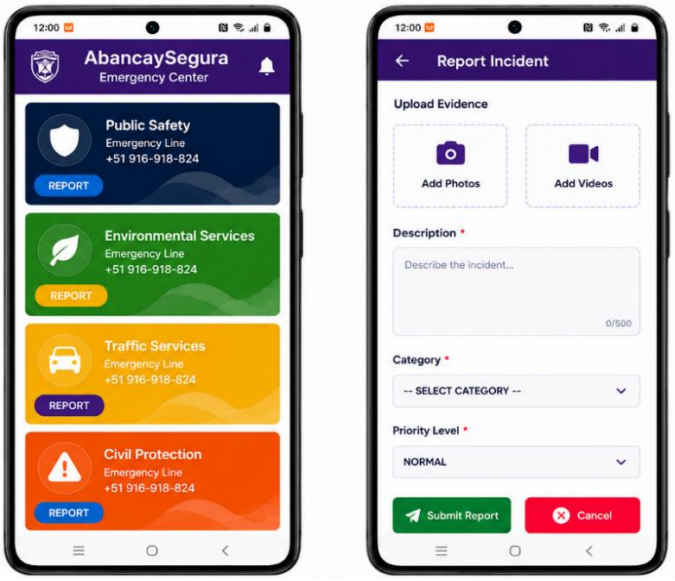
The system implementation enabled the deployment of the functionalities defined during the development phase, providing a solution focused on real-time incident reporting and response. The mobile application was designed to facilitate interaction between citizens and the municipal departments responsible for incident handling, supporting the registration, monitoring, and management of incidents related to public safety, environmental issues, traffic, and civil protection.

The main interface of the application provides access to the different incident categories, as well as consultation and tracking services. Users can submit detailed information about an event by selecting the corresponding incident category and specifying its characteristics. The application also allows the attachment of multimedia evidence, including photographs and videos, thereby improving the accuracy and reliability of incident reports.

In addition, geolocation mechanisms were incorporated to associate each incident with its geographic coordinates. This functionality facilitates spatial queries and assists responsible personnel in locating and responding to incidents more efficiently.

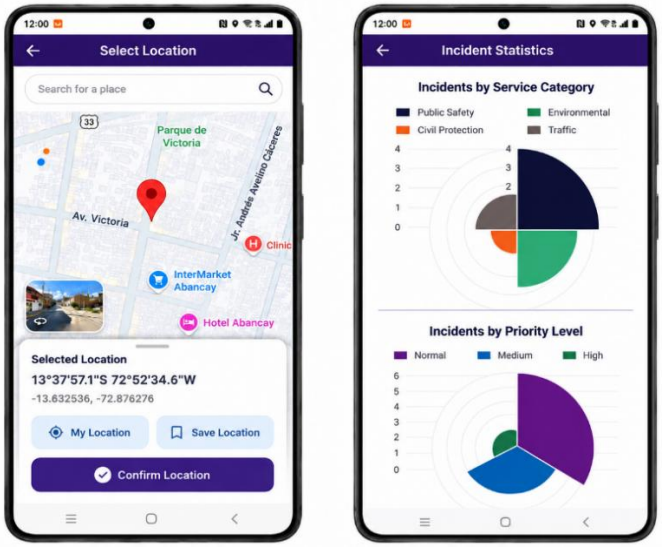
The proposed solution also incorporates monitoring and analytical capabilities that enable the generation of indicators and statistical information regarding the distribution and characteristics of reported incidents. These features provide valuable information for decision-making and support continuous monitoring of incident management activities.

The main interfaces and functionalities of the proposed mobile application are presented in Fig. 4 and 5.



(a) Main Interface (b) Incident Reporting Form.

Fig. 4. Main interfaces of the proposed mobile application: (a) Main interface and (b) Incident reporting form.



(a) Geolocation Module (b) Statistical Dashboard

Fig. 5. Additional functionalities of the proposed mobile application: (a) Geolocation module and (b) Statistical dashboard.

IV. RESULTS

The objective of this study was to evaluate the impact of the proposed mobile application on incident management within the local government environment. To achieve this, two key performance indicators (KPIs) were analyzed, namely incident registration time (KPI-1) and incident response time (KPI-2). In addition, the usability of the application was assessed using the Computer System Usability Questionnaire (CSUQ). The evaluation considered the dimensions of system quality, information quality, and interface quality to determine the level of user satisfaction with the implemented solution.

A. KPI-1: Incident Registration Time

Table II and Fig. 6 present the results obtained for the average incident registration time before and after the implementation of the proposed mobile application.

TABLE II. COMPARISON OF INCIDENT REGISTRATION TIME BEFORE AND AFTER IMPLEMENTING THE MOBILE APPLICATION

Scenario	Seconds	Minutes
Pre-Test (Without App)	9253.97	154.23
Post-Test (With App)	68.96	1.15
Reduction	9185.01	153.08
Percentage Reduction		99.26 %

The results indicate that the proposed mobile application substantially reduced the average incident registration time from 154.23 minutes to 1.15 minutes, representing a 99.26% reduction. Furthermore, the Wilcoxon signed-rank test revealed statistically significant differences ($p < 0.001$), demonstrating the effectiveness of the proposed solution in streamlining the incident registration process.

Fig. 6 provides a graphical comparison of the average incident registration times before and after implementing the mobile application.

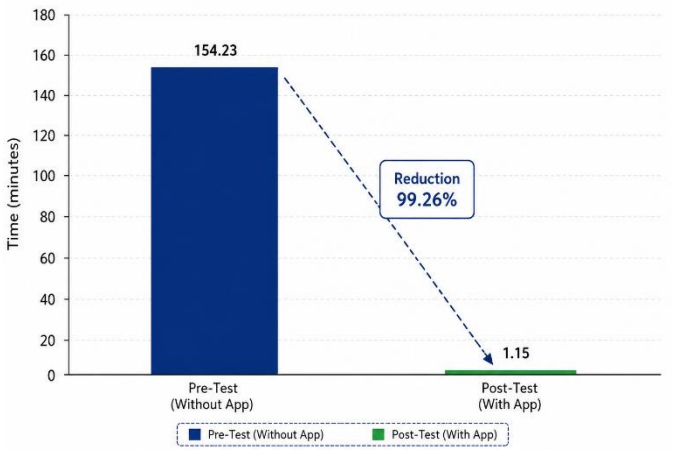


Fig. 6. Comparison of incident registration time before and after implementing the mobile application.

B. KPI-2: Incident Response Time

Table III and Fig. 7 present the results obtained for the average incident response time before and after the implementation of the proposed mobile application.

TABLE III. COMPARISON OF INCIDENT RESPONSE TIME BEFORE AND AFTER IMPLEMENTING THE MOBILE APPLICATION

Scenario	Minutes	Reduction (minutes)	Reduction (%)
Pre-Test (Without App)	94.69		
Post-Test (With App)	64.69		
Reduction			
Percentage Reduction		30.00	31.68 %

Fig. 7 presents a graphical comparison of the average incident response times before and after implementing the mobile application.

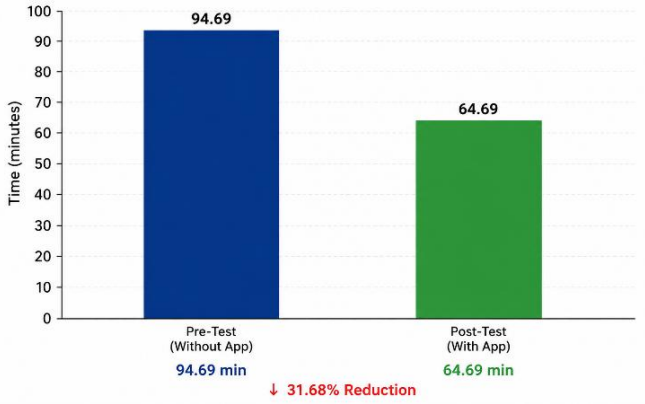


Fig. 7. Comparison of incident response time before and after implementing the mobile application.

The results indicate that the average incident response time decreased from 94.69 minutes during the pretest phase to 64.69 minutes in the posttest phase, representing a reduction of 31.68%. Furthermore, the Wilcoxon signed-rank test revealed statistically significant differences ($p < 0.001$), confirming the effectiveness of the proposed solution in improving the efficiency of incident response processes.

C. System Usability Evaluation

To determine how easy and intuitive the proposed mobile application was to use, the standard CSUQ (Computer System Usability Questionnaire) was administered. The overall satisfaction results are summarized in Table IV and Fig. 8.

The results showed a high degree of satisfaction with the proposed mobile application. Overall satisfaction reached an average score of 6.15 out of 7, reflecting a favorable user perception of the functionality, ease of use, and quality of the implemented solution. The Cronbach's alpha coefficient of 0.948 also demonstrated excellent internal consistency for the CSUQ instrument, confirming the reliability of the usability assessment.

TABLE IV. OVERALL USABILITY RESULTS OF THE PROPOSED MOBILE APPLICATION

Indicator	Value
Overall Satisfaction (CSUQ)	6.15/7
Cronbach's Alpha	0.948

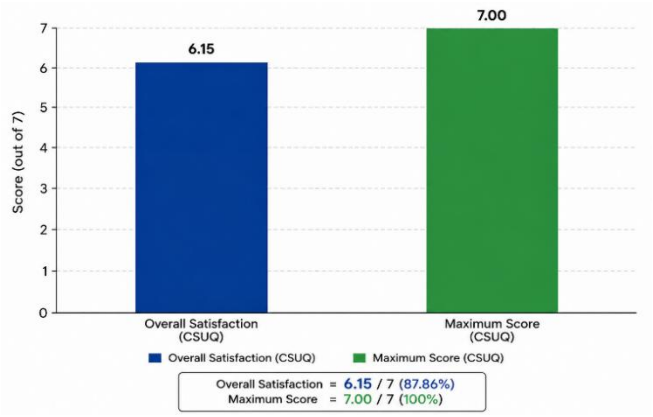


Fig. 8. Overall usability evaluation of the proposed mobile application based on the CSUQ questionnaire.

V. Discussion

The results obtained demonstrate that the proposed mobile application significantly improved incident management processes within the local government environment. In particular, substantial reductions in incident registration and response times were achieved, accompanied by high levels of user satisfaction. These findings support the notion that mobile technologies can enhance operational efficiency in incident management and contribute to the digital transformation of public services.

The findings are consistent with previous studies on mobile applications and intelligent platforms designed to support incident management and strengthen interactions between citizens and local governments [11], [15], [20]. Similarly, the high levels of user satisfaction observed in this study are in agreement with previous research emphasizing the importance of service quality, user experience, and usability evaluation in mobile government applications [22], [23], [28]. From a technological perspective, the results are also aligned with studies highlighting the advantages of Flutter and other cross-platform frameworks in terms of development productivity, performance, and user experience [29]–[32].

Overall, the findings demonstrate the potential of mobile technologies to improve incident management processes and promote stronger interactions between citizens and public institutions. These results suggest that mobile applications represent a promising technological alternative for supporting digital government initiatives and enhancing the delivery of public services.

VI. Conclusion

This study demonstrated the feasibility of using a mobile application to support real-time incident management in local government environments. The proposed solution integrated incident reporting, geolocation, and tracking capabilities, enabling more effective interaction between citizens and municipal personnel responsible for incident response. The implementation of these functionalities contributed to establishing a digital mechanism for handling incidents related to public safety, environmental issues, traffic, and civil protection.

From an operational perspective, the proposed system achieved substantial improvements in the incident management process. The average incident registration time was reduced by 99.26%, while the average incident response time decreased by 31.68%. Statistical analysis based on the Wilcoxon signed-rank test confirmed that these improvements were significant, demonstrating the positive impact of the application on the efficiency of incident management activities.

User feedback indicated a high level of acceptance of the developed application, with an overall CSUQ satisfaction score of 6.15 out of 7 and excellent internal consistency of the instrument ($\alpha = 0.948$). These results suggest that mobile technologies can serve as an effective alternative for supporting digital transformation initiatives and delivering more citizen-centered public services. Future research may focus on incorporating artificial intelligence techniques for incident prioritization and predictive analysis, as well as extending the proposed approach to other municipalities and public service domains.

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