

Design, development, and evaluation of MedEx: A geotagging and speech recognition-based emergency communication system for Candon City, Ilocos Sur, Philippines

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ABSTRACT

Efficient emergency reporting systems are critical for reducing response delays in disaster management operations. This study developed and evaluated MedEx, a mobile emergency-reporting application designed to improve the efficiency of pre-dispatch communication in Candon City, Philippines. The system integrates geotagging, speech-to-text input, multimedia reporting, and SMS-based notifications to facilitate real-time incident reporting. The study employed descriptive-developmental methods. "Data were obtained through documentary review, stakeholder interviews, end-user surveys, and system-performance simulations. The Agile Mobile-D methodology was adopted to support the iterative design and development of the application. Respondents were selected through purposive sampling, focusing on stakeholders directly involved in emergency communication processes, and responses were analyzed quantitatively using mean scores based on a 5-point Likert scale. Results showed that MedEx achieved a mean pre-dispatch time of 39.60 seconds, compared with an estimated 90 seconds under the existing manual procedure (the midpoint of a reported 1–2 minute range), representing a 56.00% reduction and a 2.27-fold improvement in processing speed. Usability evaluation yielded a grand mean of 4.34, indicating that the system is highly acceptable, with the strongest performance in learnability and operability.

INTRODUCTION

Effective communication is crucial in emergency management, as it directly affects the ability to save lives and minimize disaster consequences. Quick and accurate information sharing enables

timely decision-making, coordinated responses, and efficient allocation of resources, all of which minimize harm during crises (Lu, Liu, & Wang, 2021). Delays in communication often intensify the severity of outcomes, highlighting the importance of immediacy in emergency situations (Zhang et al., 2025). Furthermore, clear communication fosters public trust and cooperation, both of which are vital for resilient emergency operations (Fullero et al., 2024; Luiz, 2024; UN, 2015).

Recent advances in two-way digital communication technologies have improved real-time interactions, reduced misinformation, and provided emotional support during emergencies (Shahbazi & Bunker, 2024; Wang et al., 2023). Emergency communication systems have evolved to incorporate Global Positioning System (GPS) technologies and multi-channel messaging through Short Message Service (SMS), email, voice calls, and social media platforms. These developments enable information to reach diverse populations quickly and effectively (Nuevas et al., 2024). Cloud-based infrastructures further enhance reliability during large-scale incidents, while real-time dashboards facilitate centralized monitoring and data-driven decision-making (Bhalla, 2025; Ike et al., 2024).

Technologies such as geotagging, speech recognition, and SMS have increasingly been integrated into emergency systems to support hands-free reporting and improve notification speed and accuracy (Sandeep, 2025; Gouiza, Jebari, & Reklouli, 2024; Srivastava, 2024). By automating data entry processes, these technologies reduce cognitive burden during high-pressure situations and improve situational awareness among responders (Clark et al., 2017). Applications used in Cape Town emergency medical services and in U.S. law-enforcement settings demonstrate

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how speech-enabled reporting systems can enhance triage efficiency, streamline incident documentation, and enable multitasking in the field (Alshehri, Pigoga, & Wallis, 2020; Jones, 2025). Advances in artificial intelligence and natural language processing further improve speech interpretation under noisy or multilingual environments while supporting multilingual communication and interagency coordination (Gouiza, Jebari, & Reklauoui, 2024; Siohan & Braga, 2022).

The Philippines, recognized as one of the most disaster-prone countries globally, faces significant challenges in emergency communication due to its archipelagic geography and frequent natural hazards, including typhoons, earthquakes, and volcanic eruptions (Iuchi et al., 2018; Nielo, 2024). National initiatives, such as the Department of Information and Communications Technology's Government Emergency Communications System (GECS), aim to establish resilient frameworks through interoperable radio networks, mobile operations vehicles, and disaster management information systems (Caliwan, 2025). Complementary national programs, such as GeoRiskPH hazard mapping (Vacabalo & Marigondon, 2024) and the free routing of emergency 911 calls (Padlan & Mesa-Gaerlan, 2018; Caliwan, 2025), strengthen local communication infrastructures. Similarly, efforts by telecommunication providers, including Philippine Long-Distance Telephone (PLDT) Inc. and Smart, have enhanced connectivity in remote areas, improving disaster resilience.

Despite these national initiatives, several digital emergency platforms have emerged in the Philippine ecosystem, each addressing specific dimensions of the emergency response problem.

At the national level, DOST-PHIVOLCS introduced the HANDA platform, which integrates artificial intelligence-enabled hazard monitoring, location-based alerts, and disaster preparedness tools into a unified system for early warning and response (PHIVOLCS, 2026). While it offers broad early-warning capabilities, it is designed primarily for regional telemetry monitoring and broadcasting general public alerts rather than direct, localized multi-agency dispatch. The reviewed documentation did not indicate support for automated simultaneous routing of incident reports to fire, medical, and police units at the city or municipal level.

Similarly, the Department of Information and Communications Technology (DICT) eGovPH Super App incorporates the PNP Law Enforcement Reporting and Information System (LERIS) module, providing a direct gateway for citizens to file incident alerts to law enforcement authorities (DICT, 2025). The standalone PNP LERIS application extends incident-reporting capability to officers in the field, providing real-time incident reports. However, both implementations are primarily tailored to police response and lack multi-agency routing mechanisms structured for provincial LGUs.

Alerto PH, a DOST Technology Innovation for Commercialization (TECHNiCOM)-supported initiative, connects third-party hardware Internet of Things (IoT) "sensors—such as physical smoke alarms and flood detectors deployed across fixed zones—directly to LGU command centers for automated emergency alerts (DOST, 2025). This reliance on stationary perimeter hardware makes Alerto PH inherently inflexible for dynamic, spontaneous field reporting by citizens. Localized applications such as ProjectLIGTAS and the Bayan Emergency Barangay App address geographically specific needs - specifically Metro Manila storm surge water level monitoring and barangay-level flood map visualization - without integrating multimodal input processing or multi-agency dispatch capabilities.

From the citizen-accessibility perspective, SAFE (Silent Assistance for Emergencies) provides a one-tap emergency reporting interface specifically designed for deaf and speech-impaired users on Android (Birog et al., 2026), while E-LIGTAS,

developed by UP Manila, focuses on tracking, mapping, and reporting resource needs and damage assessments during disaster response (Rey, 2019). Although both platforms lower reporting barriers for specific user groups, neither integrates automated geotagging, voice recognition, nor dual-mode connectivity. Furthermore, Bridgefy, a Bluetooth mesh-messaging application, addresses a related but distinct connectivity problem by enabling communication without Wi-Fi or mobile data during cellular outages (Eikenberg, 2021). Although Bridgefy addresses connectivity disruptions, its architecture is constrained by proximity range, making it unsuitable for reporting to centralized dispatch hubs across a city, and it does not support agency-level routing of emergency incidents.

Consequently, a critical gap remains within the reviewed literature and identified emergency communication platforms: among the reviewed systems, none was identified as simultaneously providing localized multi-agency dispatch, GSM-based offline fallback, automated geotagging, and hands-free voice reporting designed for deployment at the municipal LGU level.

These concerns are particularly relevant to Candon City, Ilocos Sur, Philippines. As an emerging urban center pursuing Smart City initiatives, Candon City has adopted several digital innovations, including QR-based cashless transactions and disease detection systems supported by the Department of Science and Technology (IATT, 2021; Palmones & Maravilla, 2025; Quimoyog, 2025). However, studies indicate that despite increasing levels of disaster awareness, gaps in emergency communication efficiency and preparedness remain (Unciano et al., 2022). Behavioral responses to mobile alerts are strongly influenced by message clarity, timing, and institutional trust (Elejalde et al., 2025), while social-media-based disaster communication has demonstrated potential to improve preparedness among younger populations (Haresco & Jose, 2021). These findings suggest the importance of developing localized communication mechanisms that effectively bridge information dissemination and community action.

At the specific municipal level, the Red Alert mobile application was previously introduced as a localized digital reporting alternative to bypass traditional phone queues (Cuevas et al., 2019). While Red Alert successfully established an initial digital pathway by allowing citizens to type incident descriptions into structured forms, practical field simulations revealed major operational vulnerabilities. As Red Alert functioned strictly as a manual, form-based input system, it created a heavy typing and cognitive burden for users during high-stress emergencies. Most critically, the application relied entirely on an active internet connection and lacked an offline data routing channel. Consequently, whenever local cellular data networks outages or unstable data connections, the reporting process could fail, leaving citizens unable to transmit vital location and incident data to the dispatch hub.

In response to these limitations, this study designed, developed, and evaluated MedEx, an emergency communication companion tailored for Candon City, Ilocos Sur, Philippines. MedEx bridges the critical functional gaps identified above by providing a localized, dual-connectivity client-server architecture that natively embeds hands-free speech recognition and automated high-precision geotagging. Unlike Red Alert, MedEx removes manual text-entry barriers by translating voice recordings automatically and capturing GPS telemetry in the background. Unlike national monolithic architectures, MedEx couples standard cellular web networks with a dedicated GSM gateway, helping ensure that multi-agency pre-dispatch details can still reach local command nodes when internet connectivity fails and cellular coverage remains available—a capability not identified among the reviewed emergency communication platforms targeting provincial and municipal LGUs. Accordingly, this study aimed to evaluate existing emergency communication procedures and systems in Candon City, identify essential features for a localized emergency

communication platform, develop the proposed MedEx application, and determine its acceptability among intended users.

Beyond its local relevance, this study supports the United Nations SDGs 3 (good health and well-being) and 9 (industry, innovation, and infrastructure) by strengthening community safety, fostering resilient emergency systems, and offering a scalable framework for other smart-city initiatives in the Philippines (UN, 2015).

MATERIALS AND METHODS

Study Design

This study employed a descriptive-developmental research design to address communication barriers during emergency situations in Candon City, Ilocos Sur, Philippines. The descriptive component examined existing emergency reporting and response mechanisms, identifying strengths, gaps, and user expectations through literature reviews, surveys, and semi-structured interviews. These insights provided an empirical baseline for the system functional requirements of the proposed system.

The developmental component focused on the iterative creation and refinement of the MedEx application using the Agile Mobile-D software development methodology. This approach emphasized rapid, incremental cycles of design, implementation, and testing, enabling the continuous integration of user feedback to help ensure that the system addressed the practical operational needs of both frontline responders and the general community.

System Architecture and Technical Design

The technical architecture of MedEx, illustrated in Figure 1, follows a decoupled client-server design intended to support operational continuity under varying network conditions. The architecture consists of two major subsystems: the client mobile application and the command center dashboard. These subsystems communicate through a dual-connectivity routing mechanism that selects a transmission pathway at the time of submission, using internet-based transmission when a connection is available and GSM-based SMS as a fallback when it is not. This design addresses the communication disruptions commonly encountered in provincial settings and supports emergency reporting and dispatch operations when internet connectivity is limited.

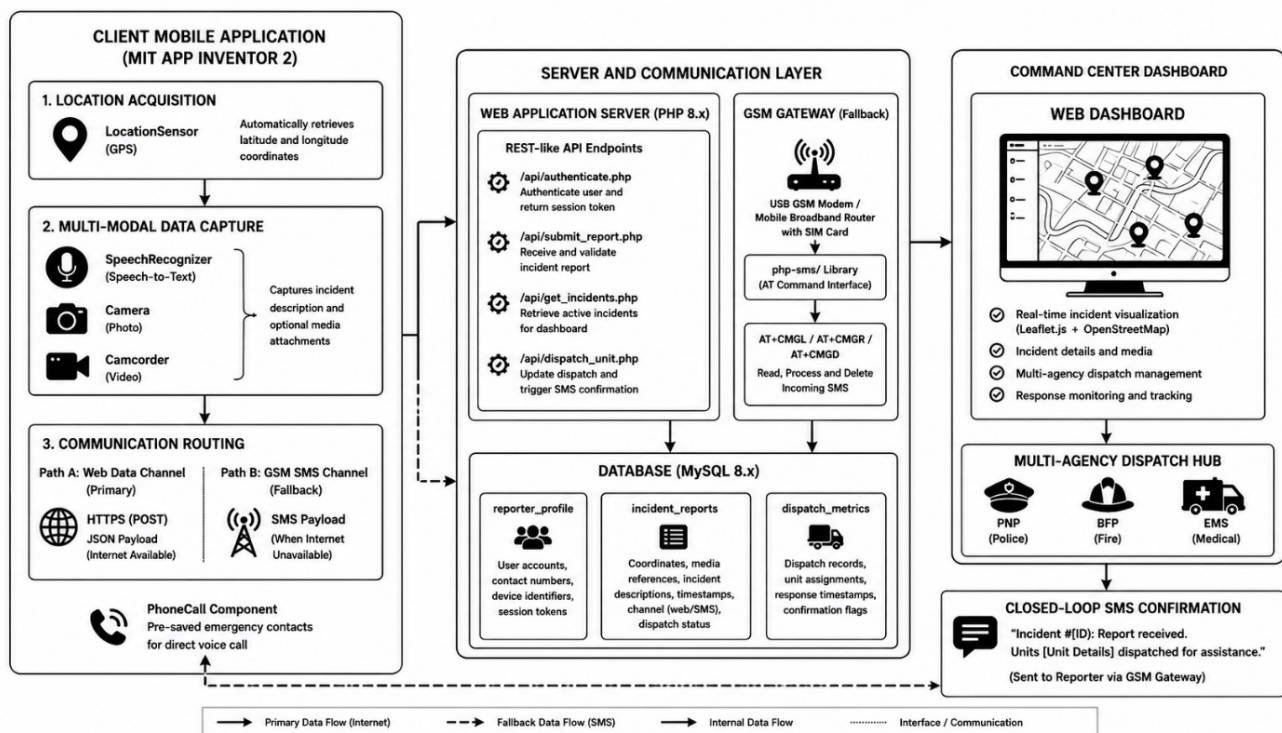


Figure 1: MedEx decoupled client-server architecture

Unlike conventional emergency reporting systems that rely exclusively on internet connectivity, MedEx integrates automated geotagging, hands-free speech-to-text reporting, and GSM-enabled offline fallback within a unified municipal-level emergency dispatch workflow. The technical novelty of the system lies not in any individual component in isolation, but in their simultaneous integration within a deployment architecture tailored to the operational realities of provincial local government units (LGUs). Based on the reviewed literature and emergency communication platforms examined in this study, none of the reviewed systems concurrently incorporated automated geotagging, voice-to-text incident capture, dual-channel connectivity with GSM fallback, and localized multi-agency dispatch routing within a single municipal-level implementation. This integrated architecture was designed specifically to address communication interruptions, reporting inefficiencies, and coordination challenges commonly encountered by municipal emergency response systems in provincial settings.

1) Client Mobile Application

The client mobile application was developed using MIT App Inventor 2 (AI2), a visual block-based Android development framework that provides native access to smartphone sensors and communication services through built-in components. AI2 was selected as it enabled rapid prototyping and seamless integration of location sensing, speech recognition, SMS messaging, camera access, and telephony functions without requiring external third-party libraries. The client application follows a sequential operational workflow designed to minimize cognitive burden during high-stress incidents:

1.1. Automatic Location Acquisition. Upon activation, the application automatically retrieves the reporter's geographic coordinates using the native LocationSensor component. The component interfaces directly with Android Location Services and uses GPS signals and network-based positioning to

determine the reporter's location. The resulting latitude and longitude values are stored as decimal-degree coordinates without requiring manual user input.

1.2. *Multimodal Sensory Data Capture.* Following localization, the application initiates multimodal data acquisition. The Speech Recognition component interfaces with Android's SpeechRecognizer API to convert spoken incident descriptions into structured text. Simultaneously, the native Camera and Camcorder components enable reporters to attach photographs or videos to incident reports. Captured media are encoded as Base64 strings and temporarily cached for transmission.

1.3. *Communication Routing System.* After data acquisition, the Communication Routing System evaluates network availability and automatically selects one of two transmission pathways:

1.3.1. *Web Data Channel (Primary).* If internet connectivity is available, the application invokes the native Web component to transmit incident reports through HTTPS using HTTP POST requests directed to the server endpoint:

/api/submit_report.php

The JSON payload contains the latitude and longitude coordinates, speech-transcribed incident descriptions, Base64-encoded media attachments, reporter identifiers, and device-generated timestamps. Token-based authentication and server-side validation mechanisms were implemented to mitigate unauthorized access and malformed submissions.

1.3.2. *GSM Fallback Channel (Offline).* When internet connectivity is unavailable, the system automatically switches to a GSM-based SMS fallback channel that transmits essential incident information, including location coordinates and incident descriptions, to the command center. Multimedia attachments remain available only through the internet-based transmission channel. To minimize message length and ensure reliable delivery, GPS coordinates and incident metadata are encoded into a compact standardized SMS format:

[id] | [latitude] | [longitude] | [truncated incident text]

The message is sent directly to the Subscriber Identity Module (SIM) number of the command center's GSM modem. This pathway bypasses internet infrastructure but still depends on cellular network availability. The PhoneCall component additionally exposes preconfigured emergency contact numbers, allowing users to establish direct voice communication when immediate coordination is required.

2) Command Center Dashboard

The command center dashboard adopts a three-tier web architecture consisting of a Presentation Layer (HTML5/CSS3 dispatcher interface), an Application Layer (PHP 7.4 server-side processing), and a Data Layer (MySQL 8.0 relational database). This separation of concerns enhances maintainability, scalability, and modularity while supporting real-time emergency dispatch operations.

3) Technology Stack

To provide a consolidated overview of the technologies employed in the development and deployment of MedEx, Table 1 summarizes the frameworks, libraries, databases, APIs, communication protocols, and hardware components utilized in the system architecture.

Table 1: Technology Stack of the MedEx System

Layer	Technology	Purpose
Mobile Frontend	MIT App Inventor 2	Android client application development.
Mobile Components	LocationSensor, SpeechRecognizer, Camera, Camcorder, Texting, PhoneCall	Access to device sensors and communication services.
Mobile APIs	Android Location Services API, Android SpeechRecognizer API	Location acquisition and speech-to-text conversion.
Backend	PHP 7.4	Server-side processing and business logic.
Database	MySQL 8.0	Storage of incident, user, and dispatch data.
Dashboard Frontend	HTML5/CSS3	Dispatcher user interface.
Mapping Library	Leaflet.js v1.7.1	Real-time geographic visualization.
Map provider	OpenStreetMap	Basemap and map tile services.
GSM Integration	php-serial	Serial communication with GSM modem.
Hardware	GSM modem with a dedicated SIM card	SMS fallback gateway.
Communication Protocols	HTTPS, HTTP POST, SMS	Incident transmission mechanisms.
Security Mechanisms	Token validation, input sanitization	Authentication and data integrity.

4) REST-like API Endpoints

The application layer exposes several REST-like endpoints implemented in PHP to support communication between the mobile application and the command center, as illustrated in Table 2.

Table 2: MedEx REST-like API Endpoints

Endpoint	Method	Description
/api/submit_report.php	POST	Receives JSON incident payload from client mobile app; executes input sanitization, coordinate validation, and data-integrity checks before writing to the database.
/api/dispatch_unit.php	POST	Accepts dispatcher-initiated unit assignment; updates incident record status and triggers GSM confirmation SMS.

/api/get_incidents.php	POST	Returns a JSON array of active incident records filtered by status and timestamp for dashboard rendering.
/api/authenticate.php	POST	Validates reporter credentials and returns a session token used in subsequent API calls.

5) GSM Fallback Processing

Reports sent through the SMS fallback channel reach the command center as follows. The mobile application sends the encoded message over the cellular network to the SIM number of a GSM modem attached to the command center server, and the modem holds incoming messages in its buffer. The backend communicates with this modem, which is equipped with a dedicated SIM card, using the php-serial library. Hayes AT commands (AT+CMGL, AT+CMGR, and AT+CMGD) are executed periodically to list, read, and delete incoming SMS reports from the modem buffer. Parsed reports are subsequently inserted into the central database using the same validation procedure employed for web-submitted incidents.

6) Database Schema

The MedEx database organizes operational data into three primary relational tables, as summarized in Table 3.

Table 3: MedEx Database Schema Summary

Table	Key Fields
reporter_profile	User credentials, contact numbers, device identifiers, session tokens.
incident_reports	Coordinates, media references, incident descriptions, timestamps, connectivity channels, dispatch status.
dispatch_metrics	Dispatch assignments, responder identifiers, response timestamps, confirmation flags.

7) Closed-Loop Confirmation System

Once dispatch confirmation is recorded within the dispatch_metrics table, the backend automatically transmits an acknowledgment SMS through the GSM gateway to the reporter. The confirmation message follows the format:

Incident #[ID]: Report received. Units [Unit Details] dispatched for assistance.

This mechanism closes the reporting-to-dispatch communication loop by informing reporters that their requests have been successfully processed and that emergency responders are en route.

Population

Purposive sampling was used to select participants with direct experience in emergency communication workflows. The study involved 50 respondents, consisting of 8 professional emergency responders (2 disaster risk reduction officers, 2 firefighters, 2 police officers, and 2 paramedics) and 42 local community members with prior experience in emergency incident reporting. This composition ensured that respondents could provide practical insights on both existing emergency reporting procedures and the usability of the developed system.

From the 50 respondents, a subset of 20 participants was selected to perform the system performance evaluation using convenience sampling. The subset comprised all 8 professional emergency

responders and 12 community members, who were selected based on their availability during the testing period. This subset is distinct from the 20 respondents in Cuevas et al. (2019) whose data informed the manual reporting baseline (see Table 5).

Setting

This study was conducted in the City of Candon, Province of Ilocos Sur, Philippines. The city center is located at approximately 17.1953° North latitude and 120.4486° East longitude (Philippine Statistics Authority, 2021). The research, system development, and evaluation activities were conducted from December 2019 to December 2020.

Study Tools

To establish a baseline understanding of existing emergency reporting procedures in Candon City, the study reviewed documentary sources, stakeholder interviews, and previously published findings, including the emergency response assessment reported by Cuevas et al. (2019). These sources provided contextual information regarding preparedness, communication efficiency, operational effectiveness, and existing communication workflows.

To evaluate the developed MedEx application, a structured software product evaluation instrument adapted from Januhari, Ronda, and Wijaya (2024) was employed. The instrument is based on the usability characteristics of the ISO/IEC 9126 software quality model. This model was retained because the adapted instrument is a validated tool built on it, and its five sub-characteristics cover the usability aspects of interest in this study: understandability, learnability, operability, attractiveness, and usability compliance.

In addition, objective system performance evaluation was conducted through participant-conducted simulation trials. System-generated logs were used to record submission, reception, and retrieval timestamps for each incident report, enabling the measurement of transmission intervals, pre-dispatch time, transaction success rate, percentage reduction in pre-dispatch time, and improvement factor. Pre-dispatch time was defined as the elapsed time between submission of the report on the client device and its retrieval by the dispatcher on the command center dashboard. The speech recognition capability of the system was further evaluated using Word Error Rate (WER) computed from standardized emergency-reporting phrases under different speech conditions.

Data Collection

Data were collected through documentary analysis, stakeholder interviews, participant surveys, software evaluation instruments, speech recognition testing, and system performance simulations. Documentary analysis and interviews were conducted to examine existing emergency reporting procedures, communication workflows, and inter-agency coordination mechanisms in Candon City.

For software evaluation, respondents completed structured assessment instruments after interacting with the developed MedEx application. Speech recognition testing involved the use of standardized emergency-reporting phrases spoken under clear speech, rapid speech, and background-noise conditions. System performance data were obtained through participant-conducted simulation trials, during which the application automatically recorded submission, reception, and retrieval timestamps. The integration of documentary, perceptual, and empirical performance data supported the credibility and methodological robustness of the study findings.

Data Analysis

In this study, quantitative data obtained from the software evaluation instrument were analyzed using mean scores derived from five-point Likert-scale responses and interpreted according to the scale shown in Table 4.

Table 4: Five-Point Likert Scale Used in the Study

Likert Scale	Quantitative Rating	Descriptive Rating
5	4.20 – 5.00	Strongly Effective / Highly Acceptable
4	3.40 – 4.19	Effective / Acceptable
3	2.60 – 3.39	Moderately Effective / Moderately Acceptable
2	1.80 – 2.59	Slightly Effective / Slightly Acceptable
1	1.00 – 1.79	Not Effective / Not Acceptable

Indicators with mean values from 2.60 to 5.00 were considered at least moderately acceptable (or moderately effective, for the assessment of existing procedures), whereas values below 2.60 indicated areas requiring improvement. For the assessment of existing emergency reporting procedures, the descriptive ratings Strongly Effective, Effective, Moderately Effective, Slightly Effective, and Not Effective were used, while for software evaluations, the corresponding descriptors Highly Acceptable, Acceptable, Moderately Acceptable, Slightly Acceptable, and Not Acceptable were applied. Mean values were interpreted using the same quantitative intervals shown in Table 4.

Ethical Considerations

Informed consent was obtained from all individual participants. Participants were briefed on the purpose of the research, and their participation was voluntary, with the assurance that their data would remain confidential and be used solely for academic purposes. The study was reviewed and approved through an in-house review conducted by the Research Director and panel members of North Luzon Philippines State College (now ISPSC). Given that the study was conducted before a formal institutional research ethics committee was in place, no ethics protocol number was issued.

RESULTS AND DISCUSSION

Analysis of Existing Local Emergency Frameworks and Precedent Systems in Candon City, Ilocos Sur, Philippines

The existing emergency response framework in Candon City, Ilocos Sur, Philippines, relies on a combination of radio networks, hotlines, and manual coordination. As illustrated in the operational flowchart in Figure 2, the process begins when an incident report is transmitted to the local Philippine National Police (PNP) or the City Disaster Risk Reduction and Management Office (CDRRMO).

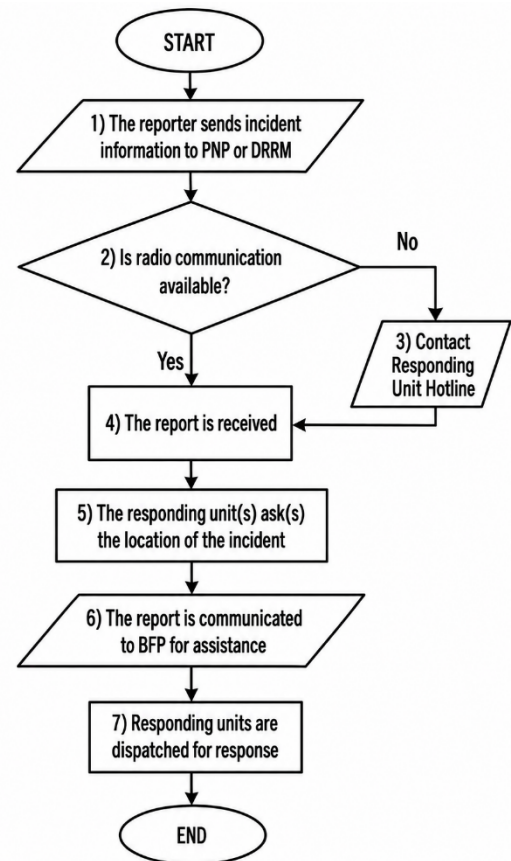


Figure 2: Flowchart of the Existing Emergency Reporting and Response Process of Candon City, Ilocos Sur, Philippines

When radio communication is available, reports are received directly by the CDRMO, allowing the response procedure to proceed immediately. However, when radio communication is unavailable or disrupted, ordinary citizens must rely on standard telephone hotlines to verbally relay details (Galang, personal communication, 2019). Interview data reveal that this manual verification and log-taking phase, referred to in this study as the pre-dispatch phase, requires approximately 1-2 min. Once an incident location is confirmed, responders take an additional 10-15 min to travel to the site under optimal conditions, resulting in an estimated cumulative response time of 11 to 17 min. Delays are more pronounced when radio communication is unavailable, as additional time is required to contact the hotline, verbally relay incident details, and manually confirm the exact location before dispatching the appropriate unit.

Overall, this system reflects a hierarchical, communication-dependent structure in which efficiency is heavily influenced by the availability of communication channels and the coordination among responding agencies. While functional, the reliance on manual communication and location verification introduces potential delays, particularly in time-sensitive emergencies.

To establish an empirical baseline for this manual emergency response system, Table 5 presents the level of effectiveness across key operational indicators as originally reported by Cuevas et al. (2019).

Table 5: Level of Effectiveness of the Existing Emergency Response Procedures in Candon City, Ilocos Sur, Philippines

Indicator	Mean	Descriptive Rating
Community Involvement and Satisfaction (Public)	4.05	Effective
Operational Activities	4.12	Effective
Community Involvement and Satisfaction (Individual)	3.98	Effective

Economic Impact	4.08	Effective
Administrative Record and Reporting	4.65	Strongly Effective
Grand Mean	4.18	Effective

4.20-5.00 Strongly Effective
3.40 – 4.19 Effective
Adapted from Cuevas et al., 2019

The baseline data, whose evaluation involved 20 respondents composed of local residents and emergency response personnel, indicate that the traditional system is generally functional, earning a grand mean of 4.18. Administrative recording scored the highest (4.65), showing that local agencies maintain a strong perceived performance in post-incident. However, individual-level community involvement scored the lowest (3.98), pointing to a clear need for tools that facilitate it easier for ordinary citizens to participate in reporting.

To address the manual communication delays identified above, the Red Alert mobile application was previously introduced in Candon City as a localized digital alternative (Cuevas et al., 2019). As shown in the operational flowchart in Figure 3, this platform attempted to bypass telephone queues by using a sequential, form-based input track.

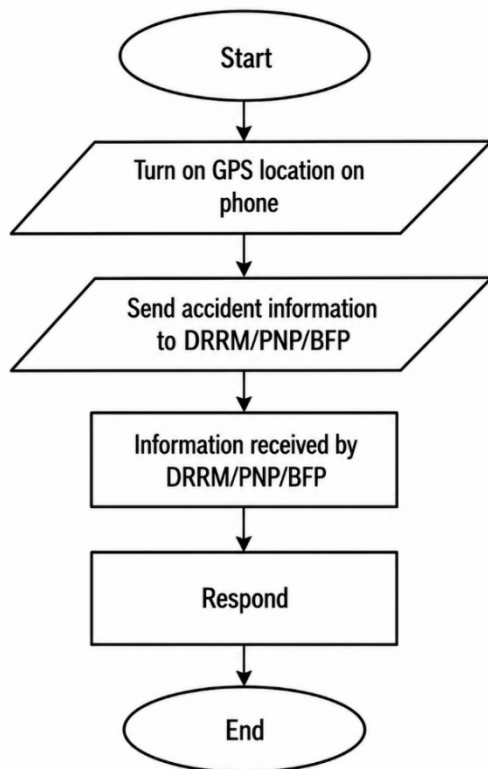


Figure 3: Operational Flowchart of the Precedent Red Alert Application

As shown in the figure, upon opening the app, users manually turned on their smartphones' GPS hardware before typing accident descriptions into structured text fields. Once submitted over an active internet connection, the text report was routed to the dispatch monitors of the CDRRMO, PNP, and BFP to initiate a rescue deployment.

However, Red Alert relied entirely on manual text entry for incident description, requiring users to type details into structured form fields during emergencies. Furthermore, location acquisition in Red Alert required users to manually activate the smartphone's GPS hardware prior to report submission. Most significantly, Red Alert depended exclusively on active internet connectivity, making

reporting unavailable during network outages or unstable data connections.

To evaluate the software acceptability of the Red Alert system as a baseline reference, Table 6 presents the quantitative evaluation metrics recorded during its deployment (Cuevas et al., 2019).

Table 6: Software Product Evaluation of the Precedent Red Alert Application

Indicator	Mean	Descriptive Rating
1. Learnability	4.60	Highly Acceptable
2. Understandability	4.47	Highly Acceptable
3. Attractiveness	4.30	Highly Acceptable
4. Usability Compliance	3.95	Acceptable
5. Operability	3.20	Moderately Acceptable
Grand Mean	4.30	Highly Acceptable

4.20–5.00 = Highly Acceptable
3.40–4.19 = Very Acceptable
Adapted from Cuevas et al., 2019

While the Red Alert application achieved a highly acceptable grand mean of 4.30, its Operability indicator returned a significantly lower mean of 3.20. This score may reflect the practical difficulties users encountered with manual GPS activation, form-based text entry under stress, and reporting issues during internet unavailability. These operability findings provide contextual support for the design considerations implemented in MedEx, which addresses each identified limitation through automated location acquisition, voice-to-text input, and dual-channel GSM connectivity.

Features of the Developed System

In response to the limitations identified in both the existing manual emergency response framework and the precedent Red Alert application, the second research objective focused on identifying system features that address the operational and communication constraints observed in prior approaches.

The system automates location acquisition through continuous background GPS tracking using the LocationSensor component, replaces manual text entry with voice-to-text reporting through the SpeechRecognizer API, and incorporates a GSM-based offline fallback channel that enables report transmission through the cellular SMS infrastructure during data network disruptions. Collectively, these features were designed to address the operational and communication constraints observed in prior approaches, with the aim of improving accessibility, timeliness, and continuity of emergency reporting and communication.

1) Speech Recognition Capability

The Speech Recognition module of MedEx enables users to verbally report emergency incidents through real-time audio-to-text conversion using the native Android SpeechRecognizer API. The module processes spoken input and generates transcribed text outputs based on the language models supported by the underlying Android operating system.

In terms of language coverage, the system primarily supports Filipino (Tagalog) and English, which are the default language models available on the tested Android devices. Although Ilocano is not an officially supported language model in the Android SpeechRecognizer API, it was included in the evaluation to assess system behavior under realistic

multilingual emergency conditions in Candon City, Ilocos Sur, Philippines, where Ilocano is widely used.

To test the system's speech recognition capability, ten standardized emergency phrases were used as the evaluation corpus. The corpus was intentionally limited to representative emergency-reporting phrases that reflect realistic incident-reporting scenarios within the intended deployment context of MedEx and was not designed to serve as a large-scale speech recognition benchmark. The phrases were grouped into Ilocano, Filipino, and English categories, as shown in Table 7.

Table 7: Speech Test Corpus

Phrase ID	Language Used	Phrase
P1	Ilocano	<i>Adda disgrasya dito!</i>
P2	Ilocano	<i>Adda naaksidente dito!</i>
P3	Ilocano	<i>Agdardara ti sakana!</i>
P4	Filipino	<i>May naaksidente po dito!</i>
P5	Filipino	<i>Mayroon pong naganap na banggaan ng sasakyan at motor dito.</i>
P6	Filipino	<i>Tulong!</i>
P7	Filipino	<i>Mayroon po akong nasaksihan na disgrasya dito sa highway.</i>
P8	English	An accident had just happened on the road!
P9	English	We need your help!
P10	English	Medics! Medics!

Each phrase was evaluated under three speech conditions: 1) clear speech at a normal speaking rate, 2) rapid speech, and 3) speech with background noise. Testing was conducted in a controlled indoor environment using representative Android devices, consistent microphone distance, and standardized recording procedures. In total, thirty (30) speech recognition trials were performed, with one trial per phrase per condition. Given this limited number of trials, the speech recognition evaluation was exploratory and was intended to indicate the system's general behavior under different speech conditions, not to serve as a robust benchmarking dataset.

The accuracy of the speech recognition was measured using the Word Error Rate (WER), a standard metric for evaluating automatic speech recognition systems. As shown in Equation (1), WER measures the proportion of recognition errors relative to the total number of words in the reference transcript (Jurafsky & Martin, 2026):

$$\text{Word Error Rate} = \frac{S + D + I}{N} \times 100 \quad (1)$$

where S represents substitutions, D represents deletions, I represent insertions, and N represents the total number of words in the reference transcript. WER computation followed standard ASR evaluation conventions in which punctuation is excluded and transcript comparison is performed in a case-insensitive manner. Punctuation is retained in the Reference Phrase and Hypothesis columns of for readability but was excluded from the scoring computation. The computations for representative phrases across each language group are presented in the following tables.

Table 8: WER Computation for an Ilocano Phrase under Rapid Speech

Reference Phrase	Hypothesis	Error
Adda	add	Substitution
-	an	Insertion
naaksidente	accidente	Substitution
dito!	dito	None

Reference: Adda naaksidente dito

Hypothesis: add an accidente dito

As presented in Table 8, the recognition output yielded two substitution errors ($S = 2$), zero deletion errors ($D = 0$), and one insertion error ($I = 1$). Applying Equation (1) with a three-word reference transcript ($N = 3$) resulted in a WER of 100.00%. A WER of 100% signifies that the total number of recognition errors was equal to the number of words in the reference phrase, indicating poor transcription accuracy for this particular Ilocano utterance. The result illustrates how rapid speech may contribute to phoneme segmentation errors in unsupported languages, resulting in substitutions and insertions that substantially increase the transcription error.

On the other hand, a representative Filipino phrase is presented in Table 9 to demonstrate recognition performance for a supported language.

Table 9: WER Computation for Filipino Phrase Across the Three Speech Conditions

Reference Phrase	Hypothesis	S (cs/rs/sbn)	D (cs/rs/sbn)	I (cs/rs/sbn)
May	may	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
naaksidente	naaksidente	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
po	po	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
dito.	dito.	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
Total Errors		0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
WER (cs/rs/sbn)		0.00% / 0.00% / 0.00%	0.00% / 0.00% / 0.00%	0.00% / 0.00% / 0.00%

Reference: May naaksidente po dito.

Hypothesis: may naaksidente po dito.

cs: clear speech

rs: rapid speech

sbn: speech with background noise

As presented in Table 9, the recognition output contained zero substitution errors ($S = 0$), zero deletion errors ($D = 0$), and zero insertion errors ($I = 0$). Applying Equation (1) with a four-word reference transcript ($N = 4$), the computed WER was 0.00%, indicating complete agreement between the reference and hypothesis transcripts. Similarly, a representative English phrase is presented in Table 10 to demonstrate recognition performance for another supported language.

Table 10: WER Computation for English Phrase Across the Three Speech Conditions

Reference Phrase	Hypothesis	S (cs/rs/sbn)	D (cs/rs/sbn)	I (cs/rs/sbn)
An	An	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
accident	accident	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
had	had	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
just	just	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
happened	happened	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
in	in	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0

the	the	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
road.	road.	0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
Total Errors		0 / 0 / 0	0 / 0 / 0	0 / 0 / 0
WER (cs/rs/sbn)		0.00% /	0.00% /	0.00% /
		0.00% /	0.00% /	0.00% /
		0.00%	0.00%	0.00%

Reference: An accident had just happened on the road.

Hypothesis: an accident had just happened on the road.

cs: clear speech

rs: rapid speech

sbn: speech with background noise

Based on the results shown in Table 10, the recognition output contained zero substitution errors ($S = 0$), zero deletion errors ($D = 0$), and zero insertion errors ($I = 0$).

Applying Equation (1) with an eight-word reference transcript ($N = 8$), and despite being the longest English phrase in the evaluation corpus, the computed WER was 0.00%, indicating complete transcription accuracy within the evaluated trial.

Together, the results presented in Tables 8–10 highlight the disparity in speech recognition performance between supported and unsupported languages. Filipino and English achieved complete transcription accuracy, whereas Ilocano exhibited substantial recognition errors within this small evaluation corpus. The computed WER values for each phrase across all three conditions are presented in Table 11.

Table 11: Computed WER of the Speech Recognition Module

Phrase ID	Language Used	N	Clear Speech (%)	Rapid Speech (%)	Background Noise (%)
P1	Ilocano	3	33.33	33.33	33.33
P2	Ilocano	3	66.67	100.00	66.67
P3	Ilocano	3	66.67	133.33	66.67
P4	Filipino	4	0.00	0.00	0.00
P5	Filipino	10	0.00	0.00	0.00
P6	Filipino	1	0.00	0.00	0.00
P7	Filipino	8	0.00	0.00	0.00
P8	English	8	0.00	0.00	0.00
P9	English	4	0.00	0.00	0.00
P10	English	2	0.00	0.00	0.00

As shown in Table 11, Filipino and English phrases achieved a WER of 0.00% across all testing conditions, indicating that the Android SpeechRecognizer API handles supported languages robustly within the evaluated scenarios. In contrast, all Ilocano phrases exhibited recognition errors, with WER values ranging from 33.33% to 133.33%. The highest error rates occurred during rapid speech, suggesting that increased speaking speed further degrades recognition performance when language model support is unavailable.

It should be noted that WER values may exceed 100% when the total number of substitution, deletion, and insertion errors exceeds the number of words in the reference transcript. This behavior follows directly from the mathematical definition of WER and is a recognized characteristic of ASR evaluation metrics (Jurafsky & Martin, 2026).

To provide a broader view of language-dependent performance, the phrase-level WER results were aggregated by language group, as shown in Table 12.

Table 12: Mean WER by Language Group

Language	Clear Speech (%)	Rapid Speech (%)	Background Noise (%)
Ilocano	55.56	88.89	55.56
Filipino	0.00	0.00	0.00
English	0.00	0.00	0.00

Based on the results, Filipino and English maintained a mean WER of 0.00% across all testing conditions, indicating error-free recognition within the tested corpus. In contrast, Ilocano recorded mean WER values of 55.56% under clear speech and background noise conditions and 88.89% under rapid speech. The increase in WER during rapid speech suggests

that speaking rate further amplifies recognition errors when language model support is unavailable.

These findings establish the operational scope and limitations of the MedEx speech recognition module. Reliable speech-based incident reporting is currently limited to Filipino and English, both of which demonstrated complete recognition performance across all evaluated conditions. Although Ilocano speech could be partially recognized, the observed WER values indicate that its transcription accuracy is insufficient for dependable emergency reporting. This limitation is likely attributable primarily to the lack of native Ilocano support within the Android SpeechRecognizer API rather than from the MedEx system architecture itself. The findings indicate that Filipino and English are currently the most reliable languages for speech-based incident reporting within the MedEx system. Future work should investigate the integration of dedicated Ilocano language models or multilingual speech recognition engines to improve accessibility and inclusivity for Ilocano-speaking users.

2) Geotagging

The geotagging feature in the developed MedEx system addresses delays in location verification by automatically capturing and transmitting the geographic coordinates of the incident to the command center upon report submission. This feature reduces dispatch delays caused by location uncertainty and is intended to improve the accuracy of responder deployment. By providing precise location information, geotagging enhances situational awareness and supports faster decision-making during emergency response operations.

3) Multimedia Attachment

The multimedia attachment feature in the developed system enables users to supplement incident reports with images or videos, allowing responders to assess the nature and context

of an emergency before arriving at the scene. This capability enhances situational awareness, supports more informed dispatch decisions, and assists responders in preparing appropriate personnel and resources. The feature operates when an internet connection is available, as multimedia files require network connectivity for transmission.

4) *SMS Integration*

SMS integration in the MedEx system serves two functions: (1) as a fallback communication mechanism for transmitting incident reports when internet connectivity is unavailable at the time of report submission, and (2) as a notification mechanism for providing status updates to incident reporters regarding report processing and emergency response actions within the system's closed-loop dispatch workflow.

For SMS-based incident reporting, the message contains the transcribed output generated by the Speech Recognition module in the format:

[id] | [latitude] | [longitude] | [truncated incident text]

To comply with the nominal 160-character GSM-7 SMS limit, the incident description is automatically truncated, when necessary, after the report identifier and geographic coordinates have been encoded. SMS transmission is automatically managed by the system and cannot be configured by the user. One SMS report is generated per incident submission when internet connectivity is unavailable. The current implementation also does not support scheduled retransmissions or repeated delivery attempts for the same incident report.

The SMS fallback mechanism is activated through a connectivity check performed during report submission within the Communication Routing System. However, the system does not continuously monitor network signal strength and therefore cannot guarantee seamless switching between internet-based transmission and GSM-based SMS fallback once transmission has begun. As a result, connectivity changes occurring during transmission may affect message delivery and are not automatically recovered in the current implementation.

In addition to fallback reporting, the system utilizes SMS notifications as part of the closed-loop confirmation system implemented at the command center. A single standardized SMS message is generated after the dispatch confirmation is recorded in the `dispatch_metrics` table, indicating that the reported incident has been successfully processed and that emergency response units have been assigned and dispatched. This message integrates both the acknowledgment of incident receipt and validation, as well as the dispatch confirmation status, into one combined notification. The notification follows the format:

Incident #[ID]: Report received. Units [Unit Details] dispatched for assistance.

This SMS notification serves as a unified status update within the incident-to-dispatch workflow of the system. It informs reporters that their incident has been successfully received, validated, and acted upon through the assignment and deployment of emergency response units. The message is strictly informational and does not require or support any response from the recipient.

Since these messages are transmitted through the GSM Gateway integrated with the server-side communication layer, they can be delivered independently of internet connectivity, provided that cellular network coverage is

available. However, delivery success remains dependent on network conditions and is not actively verified or guaranteed by the system.

Furthermore, multimedia attachments such as images and videos are transmitted exclusively through the internet-based communication channel via HTTPS, whereas the SMS fallback mechanism is limited to text-based incident information and geographic coordinates. Consequently, multimedia content cannot be transmitted through SMS and requires internet connectivity for delivery. Automatic switching between internet-based multimedia transmission and SMS-based reporting is not supported in the current implementation. The study verified the functional operation of SMS fallback reporting; however, a comprehensive evaluation of SMS delivery success rates, latency, and performance under varying cellular network conditions was beyond the scope of this study.

5) *Report Generation*

The report generation feature in the developed system provides a structured mechanism for documenting incident details, response actions, and outcomes. This supports accountability, post-incident evaluation, and operational planning, while contributing to a comprehensive record that strengthens emergency management practices.

Following the discussion of the system's functional capabilities, the study further evaluated its operational performance. Specifically, pre-dispatch time was examined as a measure of the efficiency of report transmission, receipt, and validation prior to responder deployment.

In the context of this study, submission-to-dashboard pre-dispatch processing time refers to the elapsed duration from the moment the user presses the Submit Report button until the incident report becomes available on the command center dashboard for validation and dispatch processing. It encompasses client-to-server transmission, backend processing, and dashboard retrieval and display. It excludes report creation activities such as speech input, multimedia capture, location acquisition, and form completion, as well as travel time, on-site response activities, and post-dispatch operations.

Upon successful submission, the reporter application displays the confirmation message, "Report sent successfully!", indicating that the report has been transmitted to the backend processing channel.

Under the existing manual procedure, emergency reporting typically begins when a citizen communicates an incident through direct calls, in-person reporting, or other conventional communication channels. Interviews with CDRMO personnel indicated that report receipt and validation take an estimated 1–2 minutes under normal operating conditions.

To address limitations associated with manual reporting, the earlier Red Alert system introduced digital emergency reporting capabilities. However, the corresponding study focused primarily on system functionality and did not report empirical measurements of pre-dispatch performance. Consequently, direct quantitative comparison of pre-dispatch time between the manual procedure and Red Alert is not possible based on the available data. Given this limitation, the quantitative analysis in the present study focuses on comparing the existing manual reporting procedure with the developed MedEx application.

For the developed MedEx system, timing measurements were obtained through twenty ($n = 20$) simulation trials conducted by selected participants from the respondent group. Each participant performed one simulation trial under realistic simulated usage

conditions at varying times, locations, and network environments to capture realistic variations in system performance.

During each trial, the system automatically recorded three timestamps:

1. *Submission timestamp*: the moment the user clicks the Submit Report button, marking the client-side initiation of the incident report transmission;
2. *Client acknowledgment timestamp*: the moment the application displays a confirmation message indicating

that the report was successfully transmitted, as recorded on the client; and

3. *Retrieval timestamp*: the moment the report is retrieved and displayed on the command center dashboard, marking its availability to CDRRMO personnel.

The recorded timestamps are presented in Table 13.

Table 13: Logged Submission, Reception, and Retrieval Timestamps

Trial ID	Location	Submission Timestamp	Reception Timestamp	Retrieval Timestamp
1	P*****, C**** C***	06:13:50	06:13:56	06:14:17
2	P*****, C**** C***	07:10:21	07:10:26	07:10:58
3	C**** C** P****	08:14:46	08:14:54	08:15:22
4	C**** C** P****	10:15:26	10:15:42	10:15:54
5	D***** R**, C**** C***	08:24:19	08:24:28	08:24:44
6	D***** R**, C**** C***	08:24:52	08:24:59	08:25:34
7	N***** H***** 2, B***** C***** C***	13:19:29	13:19:51	13:20:13
8	B***** C****, C**** C***	12:20:33	12:20:46	12:21:34
9	N***** H***** 2, B***** C***** C***	15:21:41	15:21:46	15:22:02
10	D**** S****, B***** C****, C***** C***	12:24:00	12:24:15	12:24:57
11	D**** S****, B***** C****, C***** C***	16:24:48	16:24:59	16:25:43
12	S** A***** B**** R**, C***** C***	10:26:08	10:26:16	10:26:53
13	S** A***** B**** R**, C***** C***	20:26:48	20:26:56	20:27:19
14	S** A***** B**** R**, C***** C***	20:27:42	20:27:50	20:28:29
15	D***** R**, C**** C***	08:30:58	08:31:12	08:31:41
16	D***** R**, C**** C***	12:31:40	12:31:47	12:32:26
17	D***** R**, C**** C***	16:33:09	16:33:14	16:33:42
18	F***** W** M****, C**** C***	11:35:17	11:35:25	11:35:45
19	F***** W** M****, C**** C***	12:35:34	12:35:42	12:36:03
20	F***** W** M****, C**** C***	22:35:50	22:36:02	22:36:47

Using the recorded timestamps in Table 13, the transmission and retrieval intervals were computed as shown in Table 14. The submission-to-reception interval represents the time required for successful report transmission from the reporter application to the backend server. The reception-to-retrieval interval represents the time required for the command center dashboard to retrieve and

display the received report. The command center dashboard was configured to refresh periodically every 30 seconds; therefore, retrieval time was partially influenced by the dashboard refresh cycle in addition to network transmission and server processing delays.

Table 14: Computed Transmission and Retrieval Intervals (in seconds)

Trial ID	Submission-to-Reception	Reception-to-Retrieval	Submission-to-Retrieval
1	6	21	27
2	5	32	37
3	8	28	36
4	16	12	28
5	9	16	25

6	7	35	42
7	22	22	44
8	13	48	61
9	5	16	21
10	15	42	57
11	11	44	55
12	8	37	45
13	8	23	31
14	8	39	47
15	14	29	43
16	7	39	46
17	5	28	33
18	8	20	28
19	8	21	29
20	12	45	57
Mean	9.75	29.85	39.60
SD	4.40	10.83	11.92
Min	5	12	21
Max	22	48	61

As shown in Table 14, analysis of the recorded logs indicated a mean submission-to-reception interval of 9.75 seconds (SD = 4.40), a mean reception-to-retrieval interval of 29.85 seconds (SD = 10.83), and an overall mean submission-to-retrieval interval of 39.60 seconds (SD = 11.92). These results indicate that incident reports were generally transmitted to the backend server in approximately 10 seconds and became available on the command center dashboard in approximately 40 seconds after submission.

The submission-to-reception interval ranged from 5 to 22 seconds, while the reception-to-retrieval interval ranged from 12 to 48 seconds. The overall submission-to-retrieval interval ranged from 21 to 61 seconds. Variations among trials were likely reflected to differences in network availability, signal quality, server processing time, and the dashboard refresh cycle. Despite these variations, all submitted reports were successfully transmitted, received, and displayed during the simulation trials, indicating stable operational performance throughout the evaluation period.

These findings suggest that the developed application provides efficient support for emergency reporting by reducing delays in the communication and information dissemination process prior to responder deployment. The observed performance characteristics indicate that the system is capable of facilitating timely incident reporting and dashboard notification under varying operational conditions.

To further assess operational performance of the MedEx system, the transaction success rate was computed as the ratio of completed report submissions to the total number of submission attempts, consistent with task-success measurement approaches commonly used in usability and system evaluation studies, as shown in Equation (2) (Albert, Tullis, & Tedesco, 2010):

$$\text{Transaction Success Rate (\%)} = \frac{\text{Successful Transactions}}{\text{Total Transactions}} \times 100 \quad (2)$$

$$\text{Transaction Success Rate (\%)} = \frac{20}{20} \times 100$$

$$\text{Transaction Success Rate (\%)} = 100.00$$

Across all twenty participant-conducted simulation trials, every submitted incident report was successfully received, acknowledged by the system, and retrieved through the command center dashboard. No failed submissions, incomplete transactions, or missing records were observed during testing. Using Equation (2), the system achieved a transaction success rate of 100.00% within the 20 evaluated trials. This result indicates that the communication and logging mechanisms consistently completed the intended reporting workflow from submission to dashboard availability under the simulated conditions.

Similarly, to assess functional suitability, functional completeness was computed as the ratio of specified functions verified to operate as intended to the total number of specified functions, as shown in Equation (3) (Sarwosri et al., 2023):

$$\text{Functional Completeness (\%)} = \frac{\text{Number of Specified Functions Verified Working}}{\text{Total Number of Specified Functions}} \times 100 \quad (3)$$

$$\text{Functional Completeness (\%)} = \frac{9}{9} \times 100$$

The nine specified functions evaluated included automated geotagging on incident submission, voice-to-text input for incident description, photo or video capture for media attachment, GSM/SMS offline fallback when internet connectivity was unavailable, incident report submission to the server, user and responder authentication, incident retrieval on the command center dashboard, unit dispatch to the responding agency, and closed-loop SMS confirmation to the reporter. All nine functions were verified to operate as designed, with no function failures or incomplete

implementations observed. Using Equation (3), the system achieved a functional completeness rate of 100.00% under the tested conditions. This result indicates that the functions implemented in MedEx fully covered the tasks and objectives specified in the system design. Functional completeness reflects implementation coverage only and does not by itself establish correctness, reliability, or production readiness.

To quantify the estimated improvement achieved by the developed system, the percentage reduction in pre-dispatch time was computed using the standard percentage decrease formula presented by Marecek, Anthony-Smith, and Mathis (2019), shown in Equation (4), based on the mean pre-dispatch interval observed across the simulation trials.

$$\text{Percentage Reduction (\%)} = \frac{\text{Original} - \text{New}}{\text{Original}} \times 100 \tag{4}$$

A representative midpoint value of 90 seconds, derived from the interview-based 1–2-minute (60–120 s) estimate of manual report receipt and validation, was used as the original value, together with the observed mean MedEx pre-dispatch interval of 39.60 seconds, in Equation (4).

$$\text{Percentage Reduction (\%)} = \frac{90 - 39.60}{90} \times 100$$

$$\text{Percentage Reduction (\%)} = 56.00$$

The result indicates an estimated reduction of approximately 56.00% in the average pre-dispatch interval relative to the midpoint manual baseline. The MedEx value was the mean submission-to-retrieval interval of 39.60 seconds obtained from all twenty participant-conducted simulation trials. Accordingly, the computed percentage reduction represents the estimated average improvement relative to the midpoint manual baseline, based on trials conducted under varying locations, network conditions, and usage environments. Similarly, the improvement factor was computed using Equation (5), based on the same values:

$$\text{Improvement Factor} = \frac{\text{Original Value}}{\text{New Value}} \tag{5}$$

$$\text{Improvement Factor} = \frac{90}{39.60}$$

$$\text{Improvement Factor} = 2.27$$

The result indicates that the manual midpoint duration was approximately 2.27 times the mean MedEx duration. Equivalently, MedEx reduced the pre-dispatch duration to about 44% of the manual midpoint. This value was computed using the mean submission-to-retrieval interval from all twenty trials and the 90-second midpoint estimate, and therefore represents an estimated average improvement rather than a directly measured one.

The results indicate that the integration of automated report transmission, backend processing, and dashboard-based incident monitoring reduced delays during the pre-dispatch phase of emergency response under the conditions evaluated in this study. However, these values represent average results obtained from participant-conducted simulation trials and are influenced by network conditions, server response time, and dashboard refresh intervals. Accordingly, the reported values should be interpreted as observed average system performance under the tested conditions, compared against an interview-based manual estimate, rather than as guaranteed operational benchmarks across all deployment environments. Nevertheless, the findings suggest that the MedEx system facilitates faster transmission and availability of incident reports compared with the existing manual reporting procedure,

thereby improving the efficiency of pre-dispatch communication during emergency reporting.

Building on these findings, the study further synthesized the results by comparing the operational performance of the existing manual procedure with that of the developed MedEx application. This comparative analysis consolidates the pre-dispatch performance metrics into a unified framework to illustrate the estimated efficiency gains achieved by the system.

Table 15: Comparison of the Existing Manual Procedure with the Developed MedEx application

Component	Existing Manual Procedure	MedEx Application	Difference
Report receipt and validation.	Estimated range: 60–120 s (interview-based)	Observed mean: 39.60 s (n = 20)	Lower than the manual range.
Mean pre-dispatch time.	90 s (midpoint estimate)	39.60 s (observed mean)	Reduced by 50.40 s relative to the 90 s midpoint.
Percentage reduction	-	56.00%	Computed from the midpoint estimate and observed mean.
Improvement factor	-	2.27×	Computed from the midpoint estimate and observed mean.

Note: The manual values are interview-based estimates and were not instrumented. The Red Alert system was excluded from the quantitative comparison because the referenced study reported no pre-dispatch timing data.

Level of Acceptability of the Developed Application as Perceived by the Respondents

The acceptability of the developed MedEx application was evaluated using the ISO/IEC 9126 software quality model, employing a 5-point Likert scale across five usability-related indicators: understandability, learnability, operability, attractiveness, and user compliance, as shown in Figure 4.

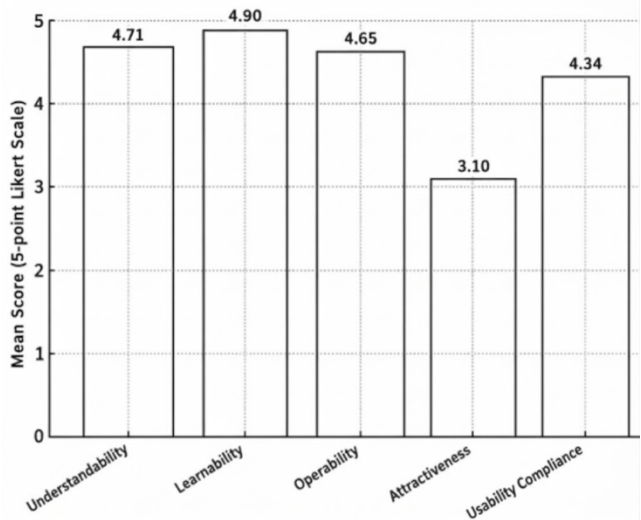


Figure 4: Level of Acceptability of the Developed MedEx Application

Results indicate that learnability obtained the highest mean score ($M = 4.90$), signifying that users were able to quickly understand and operate the system with minimal instruction. Understandability ($M = 4.71$) and operability ($M = 4.65$) also received high ratings, demonstrating that the system interface and functionality were perceived as clear and efficient in supporting task execution.

Usability compliance ($M = 4.34$) reflects that respondents were generally able to follow system workflows with minimal difficulty. In contrast, attractiveness obtained the lowest mean score ($M = 3.10$), although still within the moderately acceptable range, indicating that improvements in visual design and interface aesthetics may enhance overall user experience.

Overall, the system achieved a grand mean of 4.34, interpreted as highly acceptable based on the evaluation scale. These findings indicate that the MedEx application received favorable user ratings across the evaluated ISO/IEC 9126 usability dimensions, with particular strengths in learnability and operability.

CONCLUSION

The emergency reporting and response system in Candon City operates within a communication-dependent inter-agency framework, where efficiency is influenced by the reliability of traditional communication channels such as hotlines and radio systems. While existing processes are operationally functional, delays in report transmission and validation remain a critical limitation.

To address this, the MedEx application was developed with integrated geotagging, speech-to-text input, multimedia reporting, and SMS-based notification features. Collectively, these features were designed to enhance emergency reporting efficiency by enabling automatic location transmission, allowing visual information about incident conditions to be shared, and potentially reducing the time required for responders to obtain critical situational details before dispatch.

Empirical evaluation using twenty ($n = 20$) simulation trials showed that, relative to the 90 s midpoint estimate of the reported 1-2 min manual interval, MedEx reduced pre-dispatch time to a mean of 39.60 seconds, corresponding to an estimated 56.00% reduction and a $2.27\times$ ratio of manual to MedEx duration. In terms of usability, the system obtained a grand mean of 4.34, indicating high acceptability based on an instrument built on ISO/IEC 9126, with strong ratings in learnability and operability. Overall, the findings indicate that MedEx improves the efficiency and usability of emergency reporting by reducing pre-dispatch communication delays and facilitating faster incident reporting under the conditions evaluated in this study.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

CONTRIBUTIONS OF INDIVIDUAL AUTHORS

RJC conceptualized and developed the system, conducted data collection, analysis, and processing, and wrote and revised the manuscript.

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