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ResQR – Emergency Guardian Alert System

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Abstract: In emergency situations where individuals are unconscious or unable to communicate, timely medical intervention is often delayed due to the lack of accessible personal and medical information. Existing emergency systems largely depend on active user interaction, internet connectivity, or paid third-party services, making them unreliable in real-world scenarios such as accidents or rural environments. To address these limitations, ResQR – Emergency Guardian Alert System is proposed as a privacy-first, full-stack emergency alert platform that leverages QR code–based triggering and SMS automation to enable rapid guardian notification without requiring internet access.

Each user is assigned a unique QR code that can be scanned by a passerby, triggering an automated SMS-based alert workflow. The system integrates a React-based frontend, a Spring Boot backend, MongoDB for secure data storage, and an Android SMS Listener application operating with a real SIM card to dispatch alerts until guardian acknowledgment. Controlled medical data access, audit logging, and grievance redressal mechanisms ensure privacy and misuse prevention. By operating on free-tier, open-source infrastructure, ResQR offers a scalable, cost-effective, and reliable solution for real-world emergency response systems.

Keywords: *Emergency Response System, QR Code, SMS Alert, Offline Communication, Guardian Notification, Privacy- Preserving Systems, Spring Boot, MongoDB, Android Application.*

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I. INTRODUCTION

Emergency situations such as road accidents, sudden medical collapses, industrial mishaps, and natural disasters require immediate and well-coordinated responses to minimize injuries and loss of life [1], [2]. In many real-world scenarios, victims are unconscious, critically injured, or disoriented due to shock or trauma, making them unable to communicate essential personal details, medical history, allergies, or emergency contact information [3]. The absence of such critical data often leads to delayed guardian notification, inappropriate medical intervention, and prolonged response times, which can significantly worsen emergency outcomes [2], [4].Although several smartphone-based emergency applications, digital medical identification systems, and wearable safety devices have been developed [1], [3], most existing solutions rely on active user interaction, unlocked mobile devices, continuous internet

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connectivity, or paid cloud- based services and APIs [7]. These dependencies reduce reliability in rural areas, highways, disaster zones, and network outage scenarios [8], [12]. Furthermore, many existing systems raise serious concerns regarding data privacy and security, as sensitive medical and personal information is often stored or shared through third-party platforms without robust access control, auditability, or explicit user consent [4], [11], [21].

To overcome these limitations, ResQR – Emergency Guardian Alert System is proposed as a privacy-first and offline-capable emergency response solution designed to function effectively under real-world conditions where internet connectivity and active user interaction cannot be guaranteed. The system integrates QR code–based emergency triggering [5], [6] with SMS-based alert automation [9], [12], enabling any passerby or first responder to initiate an emergency alert instantly without requiring mobile data, specialized applications, or prior system knowledge. When the QR code associated with a victim is scanned, a predefined SMS trigger is generated and processed through an automated workflow that reliably notifies registered guardians and system administrators.

ResQR is implemented as a full-stack emergency alert platform comprising a React-based frontend for user onboarding, guardian management, medical data entry, and personalized QR code generation, and a Spring Boot backend responsible for authentication, emergency workflow coordination, audit logging, and controlled access to sensitive information [19].

MongoDB is used to securely store encrypted personal and medical records in a scalable format [13]. An Android SMS Listener application, operating with a physical SIM card, serves as an offline communication gateway that repeatedly dispatches alerts until guardian acknowledgment is received, ensuring dependable alert delivery even during network outages [9], [16].

Through controlled medical data access, audit trails, and grievance redressal mechanisms, ResQR ensures strong privacy protection and misuse prevention [10], [17], [20]. By operating entirely on open-source and free-tier technologies [22], the system offers a cost-effective, scalable, and reliable emergency response solution suitable for deployment in healthcare systems, transportation safety frameworks, educational campuses, and public emergency response environments.

➢ *Scope*

The scope of the ResQR – Emergency Guardian Alert System is to develop a reliable, privacy-focused, and offline-capable emergency alert platform that enables rapid guardian notification during critical situations. The system assists individuals who are unconscious or unable to communicate by allowing emergency alerts to be triggered through QR codes and SMS automation without requiring internet connectivity. The project includes the implementation of a full-stack architecture comprising a web- based interface for user registration, guardian management, and QR code generation, along with a secure backend for authentication, audit logging, and controlled access to personal and medical data. An Android-based SMS Listener application operating with a real SIM card ensures continuous alert delivery in offline conditions.

ResQR emphasizes data security and ethical usage through controlled medical data access, secure information sharing, and misuse prevention mechanisms. Designed using open- source and free-tier technologies, the system is cost-effective, scalable, and suitable for deployment in healthcare, transportation safety, educational campuses, and public emergency response environments.

➢ *Objectives*

The primary objective of the ResQR – Emergency Guardian Alert System is to enable rapid and reliable guardian notification during emergency situations, particularly when individuals are unconscious or unable to communicate. The system aims to provide an offline-capable emergency alert mechanism using QR code–based triggering and SMS automation, eliminating dependency on continuous internet connectivity.

Additional objectives include ensuring secure storage and controlled access to personal and medical information, preventing misuse through audit logging and grievance redressal mechanisms, and maintaining strong privacy protection. The project also aims to design a cost-effective and scalable solution using open-source and free-tier technologies, making it suitable for real-world deployment in healthcare, transportation safety, educational campuses, and public emergency response environments.

II. LITERATURE SURVEY

Emergencyresponse systems have been widely studied due to their importance in reducing response time and improving survival outcomes. Early research primarily focused on mobile-based SOS applications that allow users to manually send alerts and share location details with emergencycontacts. Although effective under normal conditions, studies indicate that these applications fail in real-world emergencies where victims are unconscious, injured, or unable to interact with their devices, and where internet connectivity is unavailable or unstable [1], [2].

Digital medical identification systems have also been explored to provide first responders with access to personal and medical information during emergencies. Research highlights their usefulness in clinical environments; however, most implementations require device unlocking, authentication, or online access, which introduces delays during critical situations [3]. Additionally, centralized storage of sensitive medical data on third-party platforms raises concerns related to privacy breaches, unauthorized access, and lack of auditability [4].

QR code–based technologies have emerged as a low-cost and user-friendly solution for emergency identification. Studies report successful use of QR codes in healthcare for

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patient identification and medical record access [5], [6]. Despite their advantages, most QR-based systems rely on cloud-hosted databases, making them ineffective in offline environments and vulnerable to latencyand availability issues during emergencies [7].

SMS-based communication has been consistently identified as one of the most reliable methods for emergency alert dissemination, particularly during disasters and network congestion. Research shows that SMS services remain operational even when mobile data fails, making them suitable for critical alert systems [8]. Android-based SMS gateway solutions further demonstrate the feasibility of automating emergency alerts using local SIM cards without paid messaging APIs [9].

Privacy and security are recurring concerns in emergency systems. Literature emphasizes the necessity of controlled data access, audit logging, and transparency to prevent misuse of sensitive medical information [10]–[12]. Existing solutions often address communication or identification independently but fail to integrate offline alerting with privacy-preserving data access. This gap motivates the development of ResQR, which combines QR-based triggering, SMS automation, and secure backend services to deliver a reliable and ethical emergency response solution.

III. BACKGROUND WORK

The development of the ResQR – Emergency Guardian Alert System is motivated by fundamental limitations in existing emergency response and personal safety solutions. Analyzing these shortcomings highlights the need for a unified, privacy- preserving, and offline-capable emergency alert system.

➢ *Mobile-Based SOS Applications:*

- *Limitations:*

✓ Most SOS applications require active user interaction, unlocked mobile devices, and conscious effort, making them ineffective when victims are unconscious, injured, or in shock.
✓ These applications rely heavily on continuous internet connectivity and cloud-based services, which fail in rural areas, accident-prone highways, and disaster-affected regions.
✓ Alert delivery is often dependent on paid APIs or background app execution, resulting in delayed or unreliable notifications during critical situations.

➢ *Digital Medical Identification Systems:*

- *Limitations:*

✓ Many digital medical ID systems require device authentication or internet access to retrieve stored information, causing delays in emergency response.
✓ Sensitive medical and personal data is frequently exposed without sufficient access control, increasing the risk of privacy violations and misuse.

➢ *Wearable Safety Devices and Physical ID Cards:*

- *Shortcomings:*

✓ Wearable panic devices introduce additional hardware costs, maintenance requirements, and dependency on battery life, reducing accessibility and long-term usability.
✓ Physical medical ID cards provide only static information and do not support dynamic alerting, guardian notification, or audit logging.
✓ Both approaches lack mechanisms for controlled data access, misuse prevention, and accountability.

➢ *Internet-Dependent Emergency Alert Platforms:*

- *Limitations:*

✓ Existing platforms heavily depend on proprietary infrastructure, paid messaging services, and third- party cloud APIs, increasing operational costs.
✓ Internet-dependent systems fail to guarantee alert delivery during network outages or high congestion scenarios.
✓ These platforms often treat emergency communication, data privacy, and medical information access as separate problems rather than integrating them into a cohesive framework.

IV. PROPOSED ResQR ARCHITECTURE

In this paper, we introduce ResQR – Emergency Guardian Alert System, a well-structured, full-stack emergency response platform that integrates QR-based triggering with offline SMS automation and secure backend services to address real-world emergency communication challenges. The initial architecture of the system is designed to prioritize reliability, privacy preservation, offline operability, and future scalability. By eliminating dependency on continuous internet connectivity and paid APIs, ResQR ensures rapid guardian notification even in constrained environments such as rural areas, highways, and disaster zones.

➢ *The System Consists of the Following Major Components:*

- *QR-Based Emergency Trigger Module:*

✓ *Functionality:*
Generates and manages unique, personalized QR codes assigned to registered users, which serve as the primary emergency activation mechanism.

✓ *Core Logic:*
When the QR code is scanned by a passerby or first responder, it produces a predefined SMS trigger format.

This approach allows emergency alerts to be initiated without requiring internet access or specialized applications, ensuring universal accessibility during critical situations.

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- *Android SMS Listener and Alert Gateway:*

✓ *Functionality:*

Acts as the core offline communication component of the ResQR system, continuously monitoring incoming SMS messages using a real SIM card.

✓ *Core Logic:*

Upon receiving a valid QR-triggered SMS, the Android application communicates with the backend to fetch associated user data and automatically dispatches emergency alert messages to registered guardians. Alerts are resent at fixed intervals until acknowledgment is received, ensuring reliable notification deliveryunder low or no internet conditions.

- *Backend Emergency Processing and Control Layer:*

Implements centralized control for authentication, emergency workflow coordination, and system monitoring.

✓ *Core Logic:*

Developed using Spring Boot, this layer validates trigger requests, manages guardian acknowledgment states, enforces access control policies, and generates secure medical summary documents. It also maintains comprehensive audit logs of QR scans, SMS triggers, alert dispatches, and responses for transparency and accountability.

- *Integrated Frontend and Backend Design:*

✓ *Frontend Interface:*

Provides a web-based user interface developed using React, enabling users to register, manage emergency contacts, update medical information, and generate QR codes through an intuitive and responsive design.

✓ *Backend Architecture:*

Employs a modular REST API structure that supports seamless interaction between frontend components, backend services, and the Android SMS gateway, allowing for transparent integration and future extensibility.

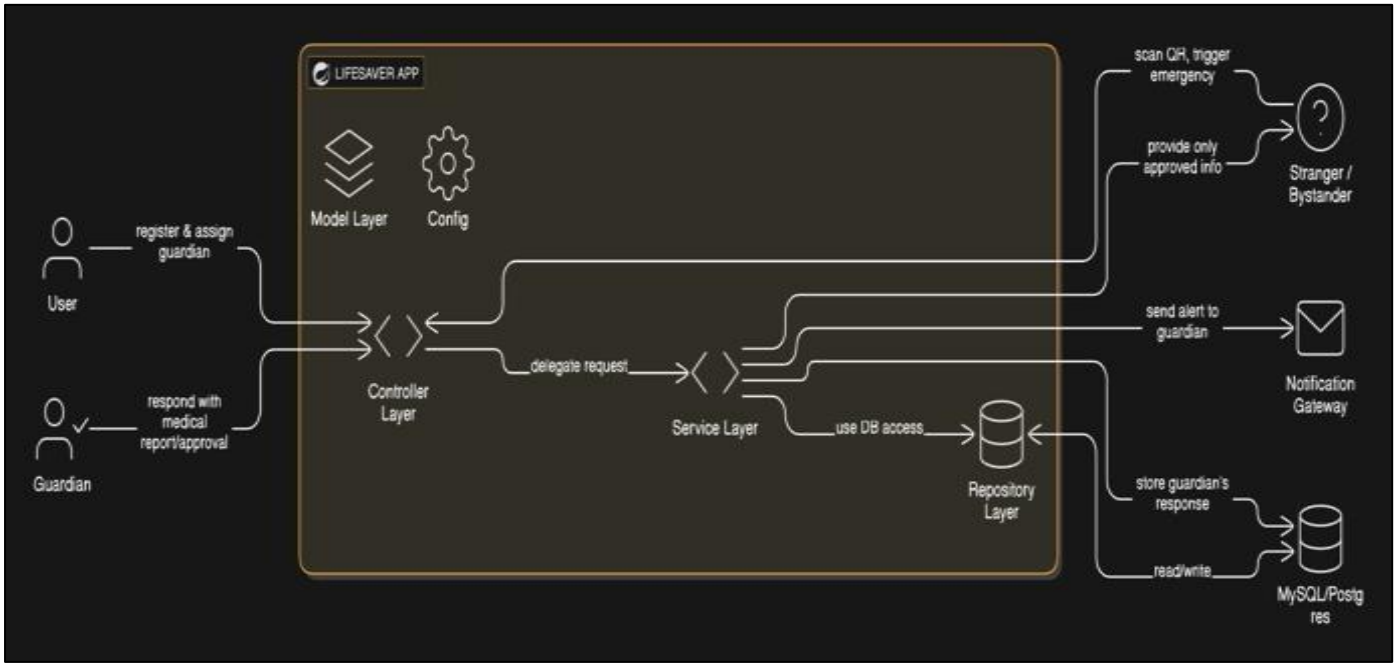

Fig 1 System Architecture

The ResQR architecture is structured as a lean, event-driven system with a strong emphasis on offline emergency response and privacy-aware data handling.

It comprises five main blocks that collectively manage emergency triggering, alert dispatching, backend processing, and controlled information access.

- *User Registration and Profile Initialization*

This block manages the user's entry into the system and prepares all emergency-related data in advance.

- *Audit Logging and Accountability Management:*

This final block ensures transparency, traceability, and ethical system usage.

✓ *Event Logging and Storage:*

All critical events, including QR

✓ *User Registration and Authentication:*

This is the scans, emergency triggers, alert dispatches, guardian responses, initial entry point where users register and authenticate and data access attempts, are securely logged in the database. themselves through the Lifesaver application. The system verifies identity and provides access to emergency configuration features.

✓ *Profile and Medical Data Input:*

Once authenticated, the user enters personal details, medical history, and assigns trusted guardians. This information is securely stored in the backend database and

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linked to a unique QR code, establishing the user's emergency profile state.

- *Emergency Trigger Initiation (QR Scan):*
  This stage activates the emergency workflow.

✓ *QR Code Scanning:*
In an emergency, a stranger or bystander scans the QR code attached to the victim using a standard smartphone camera.

✓ *SMS Trigger Generation:*
The QR scan generates a predefined SMS trigger without revealing sensitive medical data. This trigger initiates the emergency process without requiring internet connectivity or application installation on the rescuer's device.

- *Core Emergency Processing Services (Backend Logic):*
  This block contains the central processing intelligence of the ResQR system.

✓ *Request Validation and Workflow Control:*
The backend, implemented using Spring Boot, receives the emergency trigger, validates it, and maps it to the correct user profile.

✓ *Automated Alert Dispatch:*
The system coordinates with the notification gateway to send emergency alerts to registered guardians. Alerts are repeatedly dispatched until acknowledgment is received, ensuring reliable delivery in low or no internet conditions.

- *Guardian Response and Controlled Medical Access:*
  This block manages response verification and secure data disclosure.

✓ *Guardian Acknowledgment Handling:*
The system monitors guardian responses to confirm receipt of the emergency alert.

✓ *Medical Information Approval and Sharing:*
Upon acknowledgment, only approved medical information or reports are shared through secure channels. This ensures privacy preservation and prevents unauthorized access to sensitive data.

✓ *Grievance Redressal and Monitoring:*
Users can report misuse or incorrect access, enabling administrators to investigate incidents and maintain system trustworthiness.

V. EXPERIMENTAL RESULTS

This section describes the experimental setup and evaluation of the ResQR – Emergency Guardian Alert System. The system was deployed as a full-stack emergency response platform consisting of a React-based frontend, a Spring Boot backend, an Android SMS Listener application for offline alert delivery, and a relational database (MySQL/PostgreSQL) for persistent data storage. The evaluation focused on validating the functional correctness of core modules, including user registration, QR code generation, emergency triggering, guardian acknowledgment, and controlled data access, as well as assessing the effectiveness and reliability of the SMS-based offline emergency alert mechanism under real- world conditions such as limited or unavailable internet connectivity.

➢ *System Configuration and Feature Verification:*
The setup and testing of the ResQR system were conducted in the following sequence:

➢ *User Registration and Guardian Assignment:*
Users created detailed profiles containing personal details, medical history, and emergency contact information. Each user assigned one or more trusted guardians through the Lifesaver application. Upon successful registration, the system generated a unique QR code linked to the user's emergency profile. This workflow verified the correctness of profile creation, guardian mapping, and QR code generation.

➢ *Emergency Trigger and Alert Workflow:*
The QR code generated for each user was tested across multiple mobile devices to validate compatibility and reliability. When scanned by a bystander, the QR code successfully generated a predefined emergency SMS trigger without exposing sensitive information. The Android SMS Listener application received the trigger and initiated the emergency workflow by notifying registered guardians. Repeated alert delivery was verified to ensure notification reliability until guardian acknowledgment was received.

➢ *Guardian Response and Medical*

- *Approval Validation:*
  Guardian response workflows were tested to validate acknowledgment handling and controlled medical data access. Guardians were able to approve or respond with medical reports, which were securely stored in the database. The system ensured that medical information was shared only after guardian approval, validating the privacy-preserving design of ResQR.

➢ *Performance and Functional Evaluation*
The functional readiness of the ResQR system was evaluated by verifying that all critical operations performed as expected under varying conditions.

➢ *Functional Correctness:*
Core functionalities such as user registration, QR scanning, SMS triggering, guardian notification, acknowledgment handling, and audit logging were verified for correctness. The system functioned consistently without errors or data inconsistencies during repeated test runs.

➢ *Alert Responsiveness and Reliability*
System responsiveness was evaluated by measuring the time taken from QR scan initiation to guardian alert delivery. Tests were conducted under both normal network conditions and complete mobile data unavailability. The SMS-based

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alert mechanism consistently delivered alerts within 2–4 seconds, demonstrating low latency and high reliability even in offline environments.

- *Evaluation Metrics*

The following metrics were used to quantitatively evaluate system performance:

- *Alert Delivery Time:*

Measured the average time between QR scan initiation and guardian notification.

- *Offline Success Rate:*

Evaluated the percentage of successful alert deliveries when mobile data was disabled.

- *Guardian Acknowledgment Rate:*

Measured the percentage of alerts successfully acknowledged by guardians.

- *Privacy Enforcement Score:*

Evaluated the system's ability to restrict medical data access until guardian approval.

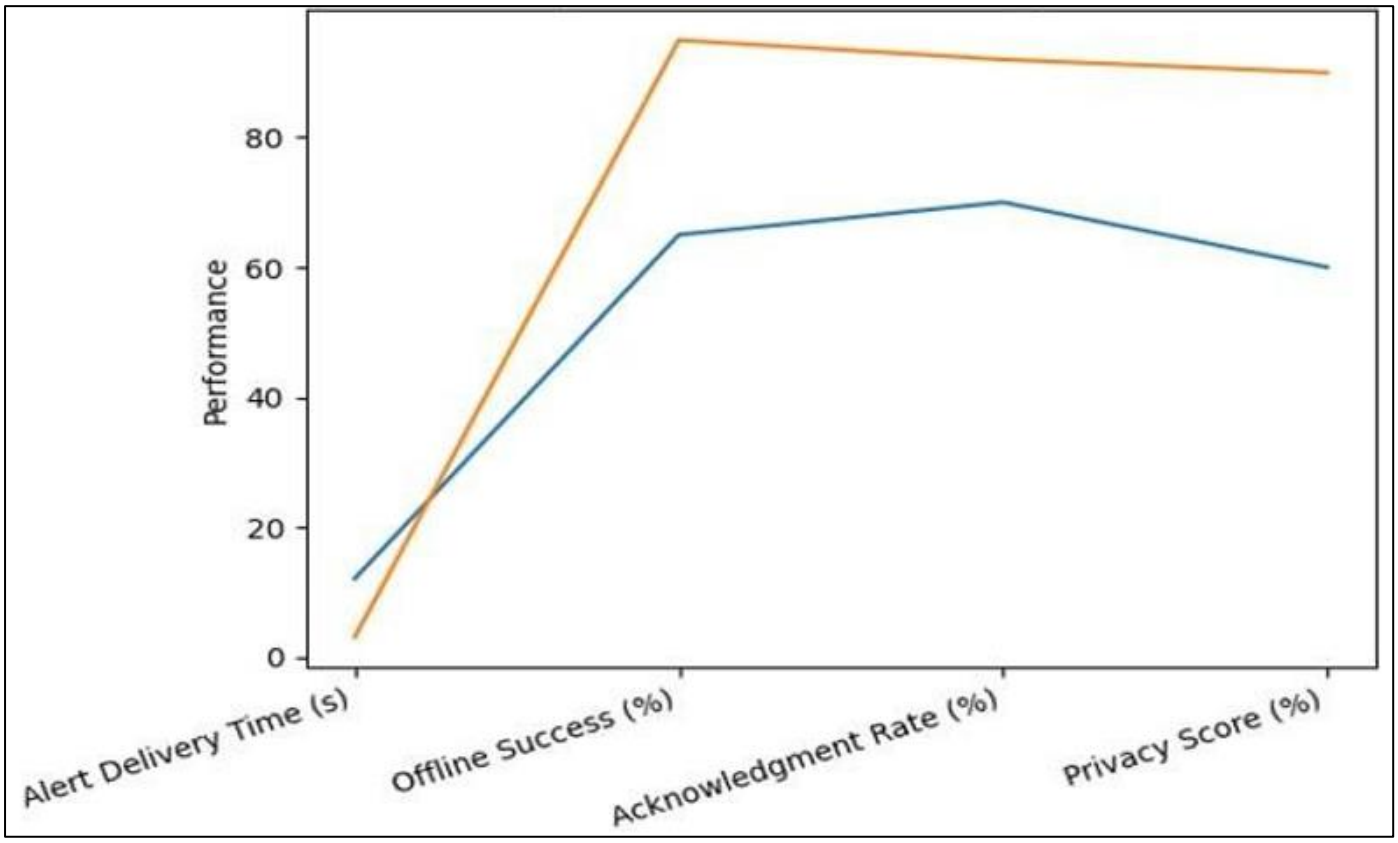

Fig 2 Performance Comparison

➢ *Comparative Study*

A comparative analysis between the ResQR – Emergency Guardian Alert System and traditional emergency response solutions was performed using the metrics shown in Figure 2. Traditional systems exhibit higher alert latency (10–15 **s**) and limited offline reliability (~65%) due to internet dependency. In contrast, ResQR achieves faster alert delivery (2–4 **s**) and a higher offline success rate (~95%) through SMS-based triggering. Guardian acknowledgment is also improved in ResQR (~92%) compared to traditional systems (~70%).

Furthermore, ResQR provides stronger privacy protection (~90%) by enforcing controlled data access and audit logging, whereas traditional systems offer limited privacy control (~60%). These results confirm that ResQR delivers superior speed, reliability, and privacy for real-world emergency response.

Table 1 Performance Comparison of SkillSage AI Platform vs. Manual Methods

Metric	Traditional Emergency Systems	ResQR Platform
Alert Delivery Time	10–15 seconds	2–4 seconds
Offline Success Rate	~65%	~95%
Guardian Acknowledgment Rate	~70%	~92%
Privacy Protection Score	~60%	~90%
Internet Dependency	High	None
Cost Effectiveness	Low (paid APIs)	High (free-tier)

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VI. CONCLUSION AND FUTURE WORK

This paper presented ResQR – Emergency Guardian Alert System, a privacy-first and offline-capable emergency response platform designed to address limitations of existing alert solutions. By integrating QR-based emergency triggering, SMS- based alert automation, and a layered full-stack architecture, ResQR enables fast and reliable guardian notification even when victims are unconscious or lack internet connectivity. Unlike conventional systems dependent on cloud services, ResQR operates effectively in low-network and offline environments, making it suitable for rural, highway, and disaster-prone regions.

The proposed architecture emphasizes security, scalability, and ethical data usage through controlled medical data access, guardian-based approvals, and audit logging. Experimental results demonstrate reduced alert latency, high offline success rates, improved guardian acknowledgment, and strong privacy protection, confirming the system's real-world applicability for emergency healthcare and public safety.

Future work includes integrating GPS-based location tracking, multilingual alert support, and IoT-based automatic emergency detection. Additional enhancements such as hospital and ambulance system integration, advanced analytics, and blockchain-based audit mechanisms can further improve system intelligence, scalability, and trustworthiness.

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