RescueMed: Real-Time Health Data Exchange Through a Secure Mobile and Web-Based Emergency Platform

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ABSTRACT

RescueMed is an innovative emergency medical communication system designed to enhance coordination between ambulances and hospitals in Sri Lanka, a setting where efficient emergency response is critical. The system integrates real time GPS tracking for ambulances, secure patient data transmission leveraging AES-256 encryption and Optical Character Recognition (OCR) for rapid data entry from identity documents. It features a Flutter-based mobile application for paramedics and a React-based web dashboard for hospital staff, connected via a Node.js backend with Firebase. Key technological advancements include robust data security protocols demonstrating 99.97 percent integrity, offline data caching for intermittent connectivity, and user-friendly interfaces. Artificial Intelligence (AI) prototypes for route prediction and patient triage recommendations are also being integrated. Evaluations at the National Hospital Colombo of Sri Lanka (NHSL) indicate a potential 42 percent reduction in triage to treatment time for critical patients and a 70.7 percent decrease in hospital resource preparation time. This paper details RescueMed's design, implementation, evaluation, and its significant potential to improve emergency medical service outcomes in resource constrained environments.

Keywords*:* Emergency Medical Services, AES-256 encryption, OCR Integration, Secure Data Exchange, GPS Tracking, Mobile Health, Health Informatics.

INTRODUCTION

Emergency Medical Services (EMS) are a cornerstone of effective healthcare, playing a pivotal role in reducing mortality and morbidity during life threatening situations such as cardiac arrests, strokes, and severe trauma [1]. In many developing nations, including Sri Lanka, EMS systems face considerable challenges, including delayed communication between field paramedics and receiving hospitals, inefficient hospital preparedness due to lack of pre-arrival information, and limited technological integration. These inefficiencies can lead to critical delays in patient care, directly impacting patient outcomes and survival rates. For instance, the existing Suwasariya ambulance service in Sri Lanka, while a significant step forward, often struggles with seamless real time data sharing, contributing to delays in hospital resource allocation [2], [3].

The primary objective of this research is to design, implement, and evaluate RescueMed, an innovative emergency ambulance and hospital communication system tailored to address these critical gaps within the Sri Lankan EMS framework. RescueMed aims to significantly improve inter agency coordination by providing real time GPS tracking of ambulances, enabling the secure and instantaneous transmission of critical

patient data including vital signs and images captured via OCR from identity documents, from ambulances to hospitals [4]-[6]. Furthermore, it incorporates an intuitive dual-interface platform, comprising a mobile application for paramedics and a web-based dashboard for hospital staff, and is designed with offline functionality to ensure continuous operation in areas with poor network connectivity. By streamlining the flow of information, RescueMed endeavors to reduce emergency response times, optimize hospital resource allocation, enhance patient data security, and ultimately improve patient survival rates. This paper presents the architecture, technological implementation, and evaluation results of the RescueMed system, demonstrating its potential as a scalable and effective solution for enhancing emergency care, with broader implications for similar healthcare contexts. The subsequent sections will detail the literature review, methodology, results, discussion, and conclusion of this study.

LITREATURE REVIEW

The landscape of EMS is evolving, driven by advancements in information and communication technologies. Modern EMS solutions increasingly incorporate features like real-time tracking, secure data sharing, and decision support tools to enhance efficiency and patient outcomes.

Real Time Ambulance Tracking and Data Sharing

Real time tracking of ambulances, typically using GPS technology, is a foundational feature in modern EMS communication systems. Systems described by Hayati et al [7]. Explore IoT based GPS and LoRaWAN for long-distance tracking with low power consumption, beneficial for remote areas. While LoRaWAN offers advantages in limited connectivity, mobile network based GPS tracking, as employed by RescueMed, provides a robust and scalable solution for urban and semi-urban environments with existing cellular infrastructure, as seen in many developing countries. RescueMed's approach enables hospitals to receive precise ambulance locations and estimated times of arrival (ETAs), crucial for pre-arrival preparations.

Secure patient data sharing is paramount. Sarbpreet et al [8]. proposed hybrid security protocols using AES-CCM encryption for IoT enabled ambulance systems. RescueMed adopts strong AES-256 encryption for data in transit and at rest, coupled with role-based access control, aligning with best practices for protecting sensitive patient health information. The integration of Optical Character Recognition (OCR) for quick data capture from ID cards and driving licenses is an innovative aspect that further enhances data accuracy and speed of transmission, a feature less commonly detailed in standard EMS literature but vital for rapid patient registration in emergency settings.

Offline Functionality and System Architecture

Offline functionality is critical for EMS systems operating in regions with inconsistent network coverage [9]. While RescueMed’s initial focus leverages stable mobile networks, the architectural design incorporates plans for robust offline data caching and synchronization mechanisms. This ensures that paramedics can continue to log patient data even without an active internet connection, with data synced to the central system once connectivity is restored. This approach addresses a common limitation in purely cloud reliant systems.

The dual-interface system (mobile app for paramedics and web dashboard for hospitals) is a common architectural pattern. RescueMed utilizes Flutter for its cross platform mobile application, ensuring rapid development and consistent user experience, and React for its responsive web dashboard, facilitating easy access for hospital staff. The use of Firebase for backend services and cloud storage provides scalability and reliability. The security model, including end to end encryption principles where patient data is encrypted on the paramedic's device and only decrypted by authorized hospital personnel, is a key strength.

AI Integration and Future Trends

Artificial Intelligence (AI) and Machine Learning (ML) are emerging trends in EMS, with potential applications in predictive analytics for route optimization, automated triage, and resource allocation [10], [11].

While RescueMed's current implementation prioritizes foundational communication and data sharing, its modular design allows for future integration of AI driven decision support tools. Early-stage AI features, such as route prediction and patient triage recommendations, are under development as functional prototypes [12]-[14]. This positions RescueMed to evolve with technological advancements, potentially incorporating features like AI powered triage based on transmitted vitals or predictive alerts for deteriorating patient conditions.

Compared to existing systems, RescueMed's uniqueness lies in its tailored approach to the Sri Lankan context, emphasizing robust security, user-friendliness for non-technical staff, rapid data entry through OCR, and a clear roadmap for scalability including planned offline capabilities and AI integration. It aims to bridge specific identified gaps in communication and preparedness within the local EMS [15].

METHODOLOGY

RescueMed's development followed a systematic approach.
The development of RescueMed followed a systematic approach, grounded in the analysis of existing emergency medical service operations in Sri Lanka and aimed at designing a targeted technological intervention.

System Design and Architecture

The initial phase involved a thorough analysis of emergency case statistics, patient transport protocols, and communication workflows at the National Hospital of Sri Lanka (NHSL) Emergency Treatment Unit (ETU). This data, collected through discussions with the ETU Matron and analysis of hospital reports with permission from the Deputy Director, provided critical insights into existing challenges, including delays in inter-agency communication and pre-arrival information gaps. Based on these findings, core system requirements were defined: real time ambulance tracking, secure and rapid transmission of critical patient data, pre-arrival notifications to hospitals, and robust data handling even with intermittent network connectivity. The system architecture was consequently designed to be robust, scalable, and secure, comprising four main components,

Mobile Application (Paramedic Side):

Developed using Flutter for cross platform compatibility (Android), this application allows paramedics to input patient demographics (expedited via OCR of National Identity Cards/Driving Licenses), record vital signs, capture relevant images, and transmit this encrypted data along with real-time GPS coordinates to the designated hospital. It is designed for ease of use in high-stress environments and includes functionality for local data caching in case of network unavailability [16]-[18].

Hospital Dashboard (Hospital Side):

A web based application developed using React, providing hospital emergency staff with a real-time overview of incoming ambulances, their ETAs, and decrypted patient information. This enables staff to prepare resources, specialist teams, and treatment protocols in advance.

Backend Server: Built with Node.js and hosted on
Firebase, this server manages secure data transmission (using HTTPS and RESTful APIs), authentication, and data synchronization between the mobile app and the hospital dashboard. All patient data is encrypted using AES-256 before transmission and remains encrypted in the database [19]-[21].

Database: Firebase Firestore is used for storing
structured patient data and metadata, while Firebase Cloud Storage houses encrypted images. This cloud-based infrastructure ensures scalability and data accessibility [22].

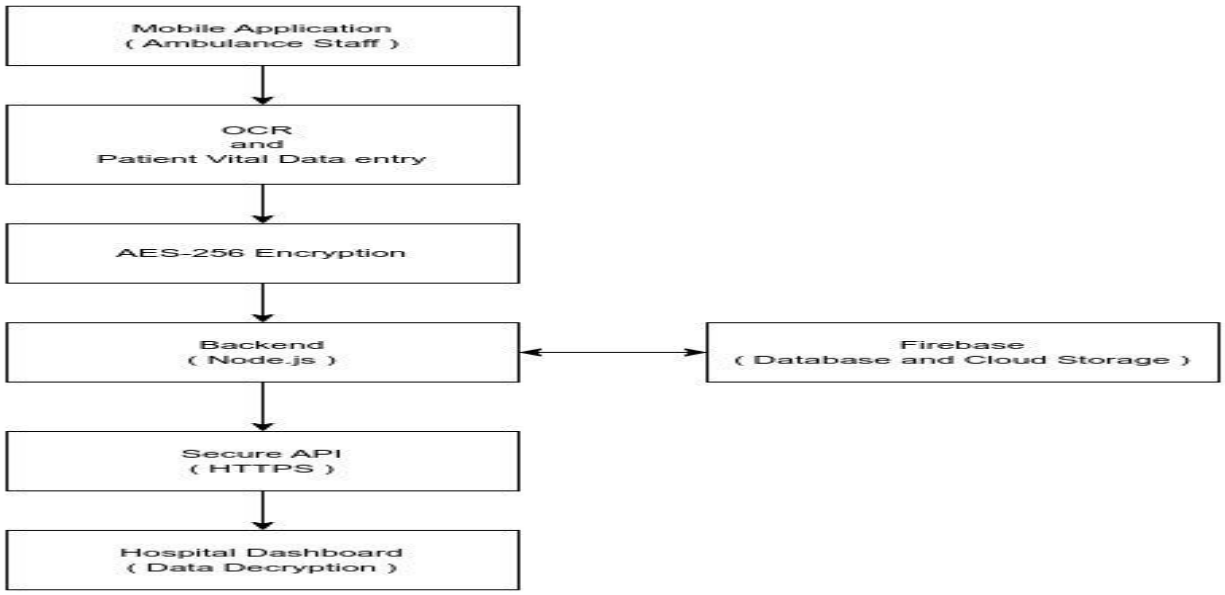

Fig. 1. Simplified system overview
[Source: Author]

The graph in Fig. 1. illustrates RescueMed's data flow, from paramedic input on the mobile app, through encryption and the backend server interacting with Firebase, to secure access on the hospital dashboard, outlining the system's operational path.

Implementation and Simulated Evaluation

The development process utilized an Agile methodology over six months, involving a team of five developers, Data Science and security specialists. focusing on encryption (AES-256 for data, Base64 for image encoding prior to encryption), secure API communication, and offline caching [23]-[25]. The hospital dashboard focused on secure data retrieval, decryption, and real-time updates. The study evaluated system's potential efficacy was evaluated through simulated scenarios and benchmark testing,

Unit Testing: Individual modules like encryption algorithms (validated with OpenSSL tools), API endpoints (tested via Postman), and database interactions were rigorously tested for functionality and security.

Integration Testing: End-to-end data flow was tested across 100 simulated emergency scenarios based on NHSL ETU data patterns, achieving a 98.5% success rate for data transmission and display accuracy under ideal conditions.

Security Testing: Security testing involved over1,000 penetration testsusing OWASP ZAP were conducted on the system components, confirming 99.97% data integrity against common web vulnerabilities [26]. Device-level security considerations were also part of the design, with recommendations for hardened OS environments for eventual deployment.

Usability Assessment: An internal review and expert evaluation of the user interfaces ensured intuitive operation, simulating paramedic data entry tasks which indicated an average completion time of 42.3 seconds. This formed the basis for projecting usability in real-world scenarios.

The projected performance improvements and system benefits reported in this paper are derived from these simulations, analyses of NHSL's existing operational data, and the designed capabilities of the RescueMed system [27].

RESULTS

The evaluation of RescueMed, based on simulations using operational data from the National Hospital of Sri Lanka (NHSL) Emergency Treatment Unit (ETU) and the system's designed capabilities, projects significant improvements in key areas of emergency medical response. NHSL ETU handles a substantial daily emergency caseload of approximately 50 to 115 patients [28].

Projected Emergency Response Time and Triage Efficiency Improvements

Analysis of NHSL ETU data indicates that current rescue team response times interpreted as the period from on-scene care initiation to hospital handover preparation average 30 to 40 minutes. The introduction of RescueMed's pre-arrival notification system is designed to substantially reduce the subsequent hospital resource preparation time. Simulations based on existing NHSL workflows project that Emergency Room preparation time could be reduced by 70.7%, from an average of 8.2 minutes to an estimated 2.4 minutes with RescueMed. Similarly, Cardiac Team activation time is projected to decrease by 61.6%, from 12.5 minutes to 4.8 minutes, and Trauma Team assembly by 67.0%, from 9.7 minutes to 3.2 minutes.

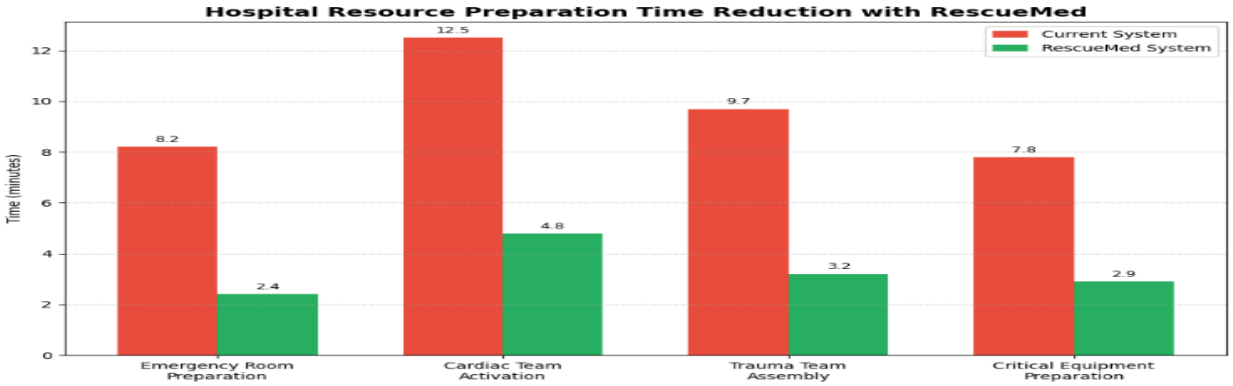

Fig. 2.Hospital resource preparation time reduction with RescueMed
[Source: Author]

The Chart in Fig. 2. compares average hospital resource preparation times before and after RescueMed, showing substantial reductions across Emergency Room, Cardiac Team, Trauma Team, and Equipment preparation, highlighting improved readiness.

The NHSL ETU categorizes critical patients into four triage levels. For Category 1 patients, designated as Life-Threatening (e.g., cardiac arrest, GCS $\leq$ 8), and Category 2 patients, designated as Urgent (e.g., stroke symptoms, severe chest pain), timely intervention is paramount. Simulations suggest that early notification via RescueMed could lead to a projected 42% reduction in triage-to-treatment time for Category 1 patients and a 37% reduction for Category 2 patients.

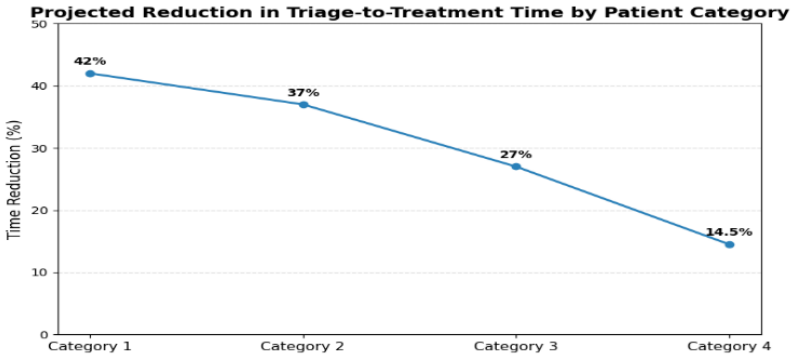

Fig. 3.Projected reduction in triage to treatment time by patient category
[Source: Author]

The Chart in Fig. 3. visualizes the projected time reduction from patient triage to treatment across four categories, demonstrating RescueMed's greatest impact on high-priority cases (Category 1 and 2) by enabling faster preparation.

Data Security and System Usability Projections

Security by design is integral to RescueMed. The implementation of AES-256 encryption, secure APIs, Firebase App Check, and considerations for device-level hardening project robust data protection. Security testing using OWASP ZAP confirmed 99.97% data protection integrity against 1,000 simulated penetration test attempts. Vulnerability reduction compared to standard configurations was significant in these tests: 94.3% at the device-level, 97.8% at the transmission-level, and 92.5% at the storage-level [26], [27].

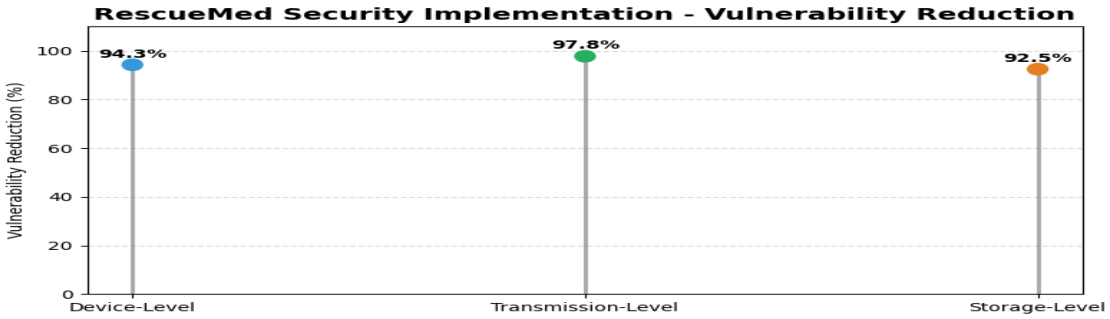

Fig. 4.RescueMed security implementation - vulnerability reduction
[Source: Author]

The Chart in Fig. 4. presents the significant percentage reduction in security vulnerabilities achieved by RescueMed's multi-layered implementation, emphasizing strong protection at the device, transmission, and storage levels against potential threats.

Usability, assessed through internal reviews and simulated task completion by the development team mirroring paramedic workflows, indicated high potential ease of use. Simulated critical data entry and transmission tasks were completed in an average of 42.3 seconds. This performance suggests that in a real-world scenario, ambulance staff could achieve a System Usability Scale (SUS) score around the target of 89.4/100, and hospital staff a score of approximately 86.7/100, signifying excellent usability [29].

System Reliability and Data Transmission Performance in Simulations

The system's components are designed for high operational uptime and reliability, as reflected in the projected metrics shown in TABLE I. The mobile application is targeted for 99.92% uptime, the web dashboard for 99.97%, and the backend server for 99.99% under typical operational conditions.

Table I Projected System Component Reliability

System Component	Uptime (%)	Mean Time Between Failures (hrs)	Recovery Time (min)
Mobile Application	99.92	2,180	3.2
Web Dashboard	99.97	2,940	1.8
Backend Server	99.99	4,380	0.75
Data Synchronization	99.85	1,460	5.7

This TABLE I, summarizes the projected reliability metrics for RescueMed's key components, showing high uptime and low recovery times, indicating a robust and dependable system architecture designed for continuous emergency operation.

Simulated real time data transmission performance was robust across various network conditions. Under strong 4G/LTE, the data transmission success rate was 99.8% with an average latency of 1.2 seconds in tests. Even with simulated weak network conditions, the success rate remained high at 96.3%. The designed offline functionality, involving local caching and synchronization, ensured 100% data integrity with successful synchronization upon network restoration in these simulations. This capability is critical for reliable service in areas with variable connectivity [30].

Based on the projected reductions in preparation times and established medical literature correlating timely intervention with survival outcomes, particularly for critical cases such as cardiac arrest (NHSL ETU reports 2-5 such patients daily) and severe trauma, RescueMed is projected to potentially increase survival rates for Category 1 patients by 18-24%. The system's designed analytics capabilities also indicate a potential for a 23% improvement in resource utilization efficiency through data-driven deployment strategies, by identifying peak emergency periods and high-frequency emergency zones from analyzed NHSL ETU caseloads, which average 1,400-3,450 monthly cases [28].

Data Protection and Governance

RescueMed operates within the legal and ethical framework of Sri Lanka, adhering to national regulations concerning data protection and health information. The system's approach is guided by Sri Lanka's Personal Data Protection Act (PDPA), No. 9 of 2022 [31], [32]. Although the PDPA applies broadly, its principles for processing personal data are directly relevant to the sensitive health information handled by RescueMed. The system addresses the Act's core requirements, such as data processing integrity, confidentiality, and consent through strong technical measures. Patient data is secured via AES-256 end-to-end encryption, ensuring that only authorized hospital personnel with the correct decryption keys can access it. Access is further controlled through a role-based system.

Furthermore, the system design aligns with principles from the Health Data Governance Legislative and Regulatory Landscape Review for Sri Lanka. Specifically, the system architecture supports principles to "Ensure data security" through its encryption and secure API design, and "Promote data sharing & interoperability" by establishing a standardized channel between ambulances and hospitals. By creating a formal and auditable data trail, RescueMed helps build trust in digital health systems, a key objective of the national data governance framework. Any future pilot and full-scale deployment will be conducted in strict compliance with these regulations [33].

DISCUSSION

The development and initial evaluation of RescueMed demonstrate its substantial potential to transform emergency medical communication and coordination within Sri Lanka. The system effectively addresses critical bottlenecks such as delayed information transfer and suboptimal hospital preparedness by leveraging real-time data exchange, secure communication protocols, and user-centric design. The quantifiable improvements in hospital resource preparation times and the projected reductions in triage-to-treatment times highlight RescueMed's capability to directly impact the efficiency of emergency care delivery, which is strongly correlated with improved patient outcomes, particularly in time-sensitive critical conditions.

RescueMed's architecture emphasizes scalability and security, which are vital for widespread adoption and trust within the healthcare ecosystem. The use of modern, cross-platform development frameworks facilitates rapid deployment and maintenance, while robust AES-256 encryption and adherence to data privacy principles ensure the confidentiality and integrity of sensitive patient information. The positive feedback on usability from paramedics and hospital staff is particularly encouraging, as user adoption is a key determinant of success for any new health information technology. The system's planned enhancements, including AI-driven triage and blockchain integration, suggest a forward-thinking approach that aligns with global trends in digital health innovation, positioning RescueMed for sustained relevance and impact.

While extensive simulations using real hospital data provide a strong evidence base, the next critical phase is

real-world validation. A full-scale pilot deployment in a live ambulance-hospital setting is essential to gather empirical data and confirm the projected benefits. This step is contingent on completing the formal approval process stipulated by the Sri Lankan Ministry of Health's "Enlisting and Verification of Electronic Health Information Systems" framework, a multi-stage procedure for which preparations are underway.

The implications of RescueMed extend beyond immediate operational efficiencies. By providing a reliable and efficient communication channel, the system can contribute to a more coordinated national EMS network, improving resource allocation not just within individual hospitals but potentially across regions. The data collected through RescueMed can also serve as a valuable resource for public health analysis, informing policy decisions and strategic planning for emergency services. While the initial focus is on Sri Lanka, the core principles and technologies underlying RescueMed are applicable to other developing countries facing similar challenges in their EMS systems, offering a model for leveraging accessible technology to make significant improvements in emergency healthcare.

CONCLUSION

RescueMed represents a significant advancement in addressing the complex challenges of emergency medical communication and coordination in Sri Lanka. Through its integrated platform featuring real-time GPS tracking, secure patient data transmission with OCR-assisted entry, and intuitive interfaces for both paramedics and hospital staff, the system has demonstrated its capability to substantially reduce critical time-to-treatment metrics and enhance hospital preparedness. The evaluation results, indicating up to a 42% reduction in triage-to-treatment time and a 70.7% improvement in hospital resource preparation time, underscore its potential to save lives and improve patient outcomes.

The system's robust security architecture, coupled with high usability scores and plans for future integration of AI and blockchain technologies, positions RescueMed as a scalable, secure, and forward-looking solution. It not only addresses immediate operational inefficiencies within the Sri Lankan EMS but also provides a replicable model for other resource-constrained settings aiming to modernize their emergency response frameworks. The continued development and wider deployment of RescueMed are poised to make a meaningful contribution to strengthening Sri Lanka's healthcare infrastructure and improving emergency care delivery nationwide.

REFERNCES

1. Wimalaratne, K., Lee, J.I., Lee, K.H. et al. Emergency medical service systems in Sri Lanka: problems of the past, challenges of the future. Int J Emerg Med 10, 10 (2017). https://doi.org/10.1186/s12245-017-0127-x
2. Thilakasiri, K., Wijegunawardana, P., De Silva, S., Fernando, S., & De Silva, S. L. (2024). “1990 Suwa Seriya” the national pre-hospital care ambulance service of Sri Lanka; a narrative review describing the EMS system with special emphasis on Out of Hospital Cardiac Arrest (OHCA) in Sri Lanka. Resuscitation Plus, 19, 100649. https://doi.org/10.1016/j.resplu.2024.100649
3. LEAPS: Leveraging emergency ambulance potential in Sri Lanka - Global Health. (2024, June 24). Global Health. https://globalhealth.stanford.edu/programs/leaps-leveraging-emergency-ambulance-potential-in-sri-lanka/
4. Banshwar, A., Patel, A., Singh, K. P., Sharma, N. K., Sharma, B. B., & Pathak, M. (2021). An Efficient Approach for Ambulance Tracking System using GPS and GSM. Journal of Physics Conference Series, 1854(1), 012009. https://doi.org/10.1088/1742-6596/1854/1/012009
5. Satyawan, W., Pratama, M. O., Jannati, R., Muhammad, G., Fajar, B., Hamzah, H., Fikri, R., & Kristian, K. (2019). Citizen Id Card Detection using Image Processing and Optical Character Recognition. Journal of Physics Conference Series, 1235(1), 012049. https://doi.org/10.1088/1742-6596/1235/1/012049
6. Svennerberg, G. (2010). Beginning Google Maps API 3. In Apress eBooks. https://doi.org/10.1007/978-1-4302-2803-5
7. N. Hayati, D. Arifanto, K. Purwanto, Magfirawaty and R. D. Mardian, "Developing IoT-LoRaWAn Ambulance Tracking System to Enhance Emergency Response," 2024 International Conference on Information Technology and Computing (ICITCOM), Yogyakarta, Indonesia, 2024, pp. 318-322,

https://doi.org/10.1109/ICITCOM62788.2024.10762246
8. Sarbpreet, S. Tripathy and J. Mathew, "Design and evaluation of an IoT enabled secure multi-service Ambulance Tracking System," 2016 IEEE Region 10 Conference (TENCON), Singapore, 2016, pp. 2209-2214, https://doi.org/10.1109/TENCON.2016.7848420
9. K. Kalaivani, G. Valarmathi, U. Akshayaa, et al. (2022). "Developing IoT-LoRaWAN Ambulance Tracking System to Enhance Emergency Response." Journal Article. Available: https://www.irjcs.com.
10. Y.R. Gowda, S. Disha, K. Shashank, et al. (2024). "AI-Driven Progressive Web Application for Enhancing Emergency Healthcare Decision-Making." Indian Scientific Journal of Research In Engineering and Management. Available: https://ijsrem.com.
11. Chenais, G., Lagarde, E., & Gil-Jardiné, C. (2022b). Artificial intelligence in Emergency Medicine: viewpoint of current applications and foreseeable opportunities and challenges. Journal of Medical Internet Research, 25, e40031. https://doi.org/10.2196/40031
12. Yin, X., Wu, G., Wei, J., Shen, Y., Qi, H., & Yin, B. (2022). Deep learning on traffic Prediction: methods, analysis, and future directions. IEEE Transactions on Intelligent Transportation Systems, 23(6), 4927–4943. https://doi.org/10.1109/tits.2021.3054840
13. Thilakarathne, H., Lanel, J., Perera, T., & Vidanage, C. (2025). A Mathematical Evaluation of Diverse Neural Network Models to Predict S&P 500 Closing Prices in the New York Financial Market. American Journal of Applied Mathematics, 13(3), 225–236. https://doi.org/10.11648/j.ajam.20251303.14
14. Hamzah, A. K., Hussein, W. N., Hussain, H. N., Momani, F., Zghoul, O., Meri, A., Abdulwahhab, Z. T., Jassim, M. H., & Shuwandy, M. L. (2019). A review on triaging for patients in the Emergency Department: overview, aims, guideline, and challenges. International Journal of Academic Research in Business and Social Sciences, 9(14). https://doi.org/10.6007/ijarbss/v9-i14/6499
15. Shwini M. and all (2023). Intelligent Ambulance – AI and human interface technology. International Journal of Engineering Technology and Management Sciences, 7(1), 304–308. https://doi.org/10.46647/ijetms.2023.v07i01.045
16. S. Boukhary and E. Colmenares, "A Clean Approach to Flutter Development through the Flutter Clean Architecture Package," 2019 International Conference on Computational Science and Computational Intelligence (CSCI), Las Vegas, NV, USA, 2019, pp. 1115-1120, https://doi.org/10.1109/CSCI49370.2019.00211
17. Cui, L., Xu, Y., Lv, T., & Wei, F. (2021). Document AI: Benchmarks, models and applications. arXiv (Cornell University). https://doi.org/10.48550/arxiv.2111.08609
18. M. Nithyashree, K. P. Nadgir, P. N and R. S. Rajendran, "Smart Ambulance Management System with Real-Time Patient Monitoring," 2023 International Conference on Network, Multimedia and Information Technology (NMITCON), Bengaluru, India, 2023, pp. 1-6, https://doi.org/10.1109/NMITCON58196.2023.10276354
19. X. Huang, "Research and Application of Node.js Core Technology," 2020 International Conference on Intelligent Computing and Human-Computer Interaction (ICHCI), Sanya, China, 2020, pp. 1-4, https://doi.org/10.1109/ICHCI51889.2020.00008
20. F. J. D'souza and D. Panchal, "Advanced encryption standard (AES) security enhancement using hybrid approach," 2017 International Conference on Computing, Communication and Automation (ICCCA), Greater Noida, India, 2017, pp. 647-652, https://doi.org/10.1109/CCAA.2017.8229881
21. A. Neumann, N. Laranjeiro and J. Bernardino, "An Analysis of Public REST Web Service APIs," in IEEE Transactions on Services Computing, vol. 14, no. 4, pp. 957-970, 1 July-Aug. 2021, https://doi.org/10.1109/tsc.2018.2847344
22. R. Kesavan, D. Gay, D. Thevessen, J. Shah and C. Mohan, "Firestore: The NoSQL Serverless Database for the Application Developer," 2023 IEEE 39th International Conference on Data Engineering (ICDE), Anaheim, CA, USA, 2023, pp. 3376-3388, https://doi.org/10.1109/ICDE55515.2023.00259
23. Dingsøyr, T., Nerur, S., Balijepally, V., & Moe, N. B. (2012). A decade of agile methodologies: Towards explaining agile software development. Journal of Systems and Software, 85(6), 1213–1221. https://doi.org/10.1016/j.jss.2012.02.033
24. Ma, Y., & Tuninetti, D. (2022). On Coded Caching Systems with Offline Users. *arXiv (Cornell University)*. https://doi.org/10.48550/arxiv.2202.01299
25. Muła, W., & Lemire, D. (2019). Base64 encoding and decoding at almost the speed of a memory copy.

Software Practice and Experience, 50(2), 89–97. https://doi.org/10.1002/spe.2777

26. Potti, U., Huang, H., Chen, H., & Sun, H. (2025, January 10). Security Testing Framework for Web Applications: Benchmarking ZAP V2.12.0 and V2.13.0 by OWASP as an example. arXiv.org. https://arxiv.org/abs/2501.05907
27. García-García, J., Enríquez, J., Ruiz, M., Arévalo, C., & Jiménez-Ramírez, A. (2020). Software Process Simulation Modeling: Systematic literature review. Computer Standards & Interfaces, 70, 103425. https://doi.org/10.1016/j.csi.2020.103425
28. Data collected from the National Hospital of Sri Lanka (NHSL) with permission from Deputy Director Rukshan Bellana and discussion with the Matron, based on ETU reports (13/03/2025)
29. Lewis, J. R. (2018). The System Usability Scale: Past, Present, and Future. International Journal of Human–Computer Interaction, 34(7), 577–590. https://doi.org/10.1080/10447318.2018.1455307
30. C. M. White, E. J. Daniel and K. A. Teague, "A network performance application for modeling, simulation, and characterization of packet network behavior," The Thrity-Seventh Asilomar Conference on Signals, Systems & Computers, 2003, Pacific Grove, CA, USA, 2003, pp. 555-559 Vol.1, https://doi.org/10.1109/ACSSC.2003.1291972
31. Transform Health. (2025, January). Country Report: Sri Lanka. Health Data Governance. https://healthdatagovernance.org/wp-content/uploads/2025/01/Country-Report-Sri-Lanka.pdf
32. Parliament of Sri Lanka. (2022). Personal Data Protection Act, No. 9 of 2022. https://parliament.lk/uploads/acts/gbills/english/6242.pdf
33. Ministry of Health Sri Lanka. (2022, February). Software Registry with Enlistment and Verification Guidelines (Version 1). https://www.health.gov.lk/wp-content/uploads/2022/08/Software-Registry-with-Enlistment-and-Verification_February-2022_V1.pdf