RESCUE CONNECT SYSTEM

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Abstract - In the face of increasing natural and man-made disasters, timely and accurate information is crucial for effective response and life-saving efforts. Disaster response agencies frequently struggle to collect relevant, real-time data from diverse sources such as social media, news outlets, and other open platforms. This project aims to develop a comprehensive software solution where the platform enables users to quickly report emergencies like floods, fires, or earthquakes by selecting from predefined disaster categories. It also allows victims to specify critical needs—such as the number of people needing rescue, food, water, or medical supplies—directly through the platform. This information is instantly relayed to the nearest disaster response teams with precise location data and navigation to ensure that critical messages reach disaster response agencies in the shortest possible time. By using GPS technology, the platform provides disaster response teams with accurate routes, minimizing delays in reaching affected areas. The platform also addresses the limitations of traditional communication networks by offering offline functionality and low-bandwidth messaging, ensuring accessibility even in remote or infrastructure-damaged areas. Peer-to-peer networking and emergency broadcast features enable uninterrupted information flow, preventing communication blackouts during critical moments.The real-time nature of the system allows for quick decision-making, empowering agencies to save lives, reduce disaster impacts, and optimize resource allocation during crises. The software is designed for all types of disasters, providing a unified interface for both responders and affected individuals.

Key Words: Disaster response, Emergency reporting, Real-time data collection, Natural and man-made disasters, Critical needs assessment, Rescue coordination, Food, water, and medical supply requests, Disaster response teams, GPS-based navigation

1. INTRODUCTION

The increasing frequency and intensity of natural disasters such as floods, wildfires, earthquakes, hurricanes, and droughts have become one of the most pressing challenges of the 21st century. Climate change has played a significant role in exacerbating these events, causing unpredictable weather patterns and extreme environmental conditions that impact vulnerable regions. The growing impact of natural disasters highlights the urgent need for comprehensive and technologically advanced disaster management strategies. Climate change has intensified the frequency and severity of these disasters, resulting in devastating humanitarian and economic consequences. Rising sea levels threaten coastal cities, prolonged droughts disrupt agriculture and water supplies, and extreme weather events cause infrastructure collapse and loss of life. Developing countries are particularly vulnerable due to weak infrastructure, limited access to resources, and inadequate disaster preparedness programs. The economic cost of disasters is also staggering, with global damages reaching hundreds of billions of dollars annually, further straining economies and increasing social inequalities. As a result, these disasters have led to devastating loss of life, widespread property damage, and long-lasting disruptions to daily life, economies, and infrastructure. Communities, especially in developing countries, often bear the brunt of these impacts, as they face limited resources and are ill-prepared for such large-scale events.

Disaster management encompassing preparedness, response, recovery, and mitigation is central to minimizing the damage and suffering caused by these events. However, despite technological advancements, many existing disaster response systems are still not fully equipped to handle the scale and complexity of modern emergencies. Traditional communication channels, such as phone calls, radio broadcasts, and social media, while useful in some contexts, often fall short during large-scale disasters. In particular, these methods can be slow, fragmented, and unreliable, especially when communication networks are damaged or overwhelmed. As a result, critical information may be delayed or lost, slowing down the ability of rescue teams to reach those in need and exacerbating the impact of the disaster. Despite advancements in science and technology, many disaster management systems remain inadequate in handling large-scale emergencies efficiently. One of the biggest challenges is the breakdown of communication networks, making it difficult for affected individuals to seek help and for emergency responders to coordinate relief efforts. Traditional methods such as phone calls and social media often become unreliable during disasters due to network congestion and infrastructure damage. Additionally, misinformation spreads quickly, leading to confusion and panic, which further hampers response efforts. Coordination between government agencies, humanitarian organizations, and private sector responders is often fragmented, resulting in delays in aid distribution and duplication of efforts. These challenges highlight the need for a more robust, streamlined, and technology-driven disaster response system.

To address these issues, there is a clear and urgent need for the development of a more efficient, reliable, and unified disaster management platform that can bridge the communication gap between disaster victims and emergency response teams. Such a platform would enable real-time data sharing, allowing individuals to report their exact locations, needs, and conditions directly to first responders. This would not only improve the speed of response but also ensure that resources such as food, medical supplies, and personnel are allocated to the areas with the greatest need. Public engagement and preparedness are also vital components of any effective disaster management strategy. A well-designed platform should not only enable communication during a disaster but also include features for educating the public on disaster preparedness, offering early warning alerts, and encouraging community-driven reporting. Empowering citizens with the right tools and knowledge can significantly reduce risks and enhance resilience in the face of future disasters.

1.1 Problem Statement

The increasing frequency of natural disasters, such as floods, fires, and earthquakes, is largely driven by climate change, leading to significant loss of life, property damage, and disruptions to daily life. Effective disaster management relies on timely and accurate communication, but traditional methods like phone calls and social media often prove slow, fragmented, or unreliable during emergencies. To address these challenges, developing a unified platform that covers all types of disasters and improves real-time data sharing such as GPS location and specific needs—between victims and rescue teams is crucial. Such a system would enable faster response times, better resource allocation, and more efficient coordination among emergency services. Additionally, integrating AI and machine learning for predictive analytics could help anticipate disaster impacts, allowing for proactive measures. Cloud-based platforms could ensure seamless data access and communication, even in areas where traditional infrastructure has failed. The increasing frequency and intensity of natural disasters demand a proactive approach to disaster management, leveraging advanced technology and coordinated response strategies. Climate change continues to accelerate the occurrence of severe weather events, causing unprecedented destruction, particularly in vulnerable regions with limited resources. While traditional disaster response methods have been helpful, they often fall short due to communication breakdowns, slow response times, and inefficient resource distribution. A robust, technology-driven disaster management platform can bridge these gaps by integrating real-time data collection, AI-powered analytics, and cloud-based communication systems to ensure swift and effective emergency responses. By utilizing GPS tracking, affected individuals can report their exact locations and specific needs, allowing emergency teams to prioritize the most critical areas and allocate resources accordingly. AI and machine learning models can analyze historical data and ongoing disaster patterns to predict the impact of an event, helping authorities implement preventive measures before catastrophe strikes. Cloud computing ensures uninterrupted access to vital information, even when local infrastructure is damaged, facilitating seamless coordination between agencies and responders.

In addition to improving response mechanisms, disaster preparedness and public engagement are crucial for minimizing the impact of such events. A comprehensive disaster management system should incorporate early warning alerts that notify people of impending dangers, along with educational resources that inform communities about safety measures, evacuation procedures, and first-aid techniques. Encouraging community-driven reporting allows individuals to share real-time information about local conditions, enhancing situational awareness for both residents and emergency responders. Governments, humanitarian organizations, and private technology companies must collaborate to build a scalable, adaptable framework that can be deployed globally. Investing in resilient infrastructure, enforcing strict environmental policies, and promoting disaster preparedness programs are all vital steps in reducing the devastation caused by natural disasters Moreover, public engagement and preparedness play a vital role in minimizing disaster risks. A well-designed system should include educational tools, early warning alerts, and community-driven reporting features to empower people with the knowledge and resources needed to stay safe. Collaboration between governments, NGOs, and technology providers is essential to building a comprehensive and scalable disaster response framework. By leveraging technology and innovation, disaster management operations can become more effective, ultimately saving lives, reducing economic losses, and fostering resilience in communities facing increasing environmental threats.

1.2 Motivation

Natural disasters are becoming increasingly frequent and severe due to climate change, causing widespread destruction, loss of life, and immense challenges for affected communities. Witnessing the devastating impacts of events like floods, wildfires, and earthquakes highlights the critical need for timely and effective disaster management. The inefficiencies and fragmentation in current communication methods often lead to delays in rescue efforts, preventable loss of lives, and prolonged suffering for victims. The increasing severity and frequency of natural disasters underscore the urgent need for more efficient and technology-driven disaster management solutions. Climate change has intensified extreme weather events, making communities more vulnerable to devastating floods, hurricanes, wildfires, and earthquakes. In many cases, the lack of an effective communication system exacerbates the crisis, as outdated and fragmented methods often fail when they are needed most. Traditional channels like phone networks, social media, and emergency hotlines become overwhelmed or disrupted, leading to confusion, misinformation, and delays in rescue operations. These inefficiencies highlight the necessity of a robust and unified disaster management platform that enables real-time data exchange, ensuring that first responders receive accurate, up-to-date information about affected areas, available resources, and the most critical needs of victims.

The motivation lies in the potential to save lives, reduce property damage, and support faster recovery by creating a unified disaster management platform. Such a platform, capable of real-time data sharing and seamless communication, would empower victims, rescue teams, and authorities to respond swiftly and effectively. The drive to harness technology for social good and improve resilience in the face of growing environmental challenges.

Abbreviation	Full Form
SOS	SAVE OUR SOULS
GPS	GLOBAL POSITIONING SYSTEM
UI	USER INTERFACE
API	APPLICATION PROGRAMMING INTERFACE
SMS	SHORT MESSAGE SERVICE
GIS	GEOGRAPHIC INFORMATION SYSTEM
IOT	INTERNET OF THINGS

Table 1: List of Abbreviations and Their Full Forms

2. Related works

2.1 Distress – An Application for Emergency Response and Disaster Management

The escalating frequency of disasters highlights the persistent inadequacies of existing disaster management systems, which often fail to provide timely and effective assistance during crises. Natural disasters are responsible for approximately 60,000 deaths annually, contributing to significant human, material, economic, and environmental losses, while also exacerbating mental health issues such as anxiety, trauma, and emotional instability among affected populations. Effective disaster management is crucial not only for minimizing the impacts of such events but also for ensuring prompt assistance to victims, thereby facilitating rapid recovery. Technology, particularly mobile technology, plays a pivotal role in enhancing disaster management and emergency response capabilities. With an estimated global smartphone user base of 3.5 billion, the development of a smartphone application is proposed to improve information management and reduce response times during emergencies. A thorough review of existing prototypes for emergency management reveals various strengths and weaknesses. For instance, Kafya allows users to report emergencies through multiple methods, such as pressing a button or using voice commands, but faces challenges with voice command accuracy. A location-based information app aims to ensure equality in participation but struggles with user engagement. A tsunami disaster response app provides critical alerts and shelter locations but requires enhancements in user interface design.

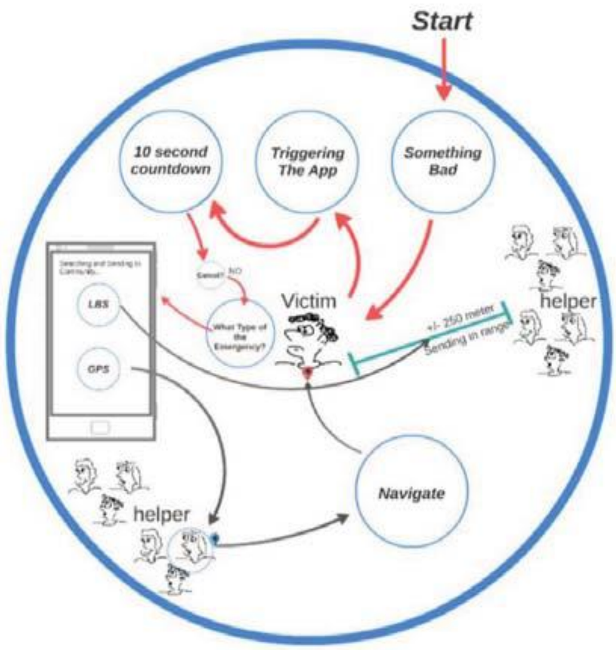

Figure 1: Application Model of Prototype proposed by V. Mody S. Parekh (2020)

An emergency communication app utilizes ad-hoc networks for communication during disasters but is limited by distance constraints. A crowdsourcing mobile app collects and manages real-time information but relies heavily on active user participation for effectiveness. Building on the strengths and weaknesses of these existing models, a new prototype is proposed that features user registration, an SOS alert system that sends notifications to emergency contacts and nearby users, incident reporting capabilities that allow users to report emergencies and verify incidents, and resource locators that provide information on the nearest hospitals, clinics, and police stations. This prototype is implemented as a web application using technologies such as Node.js, Express.js, MongoDB, and Socket.io, with Google API for user authentication and HERE Maps API for mapping functionalities. The application enables users to submit and view disaster-related data in real-time, facilitating effective communication and coordination among users and emergency responders. The application meets performance criteria such as reliability, ease of use, and timeliness, while also acknowledging the need for further improvements in connectivity, bandwidth, and overall user experience. Future work may include integration with government and relief agencies to enhance coordination and support during disasters, as well as the addition of language support to cater to a broader audience. This research contributes to the ongoing discourse on improving disaster management through innovative technological solutions.

2.2 Emergency Management System Using Android Application

A comprehensive analysis of an Emergency Management System (EMS) developed to enhance communication during disasters through a smartphone application. It emphasizes the critical need for effective communication during emergencies, as traditional methods often fail when disasters occur, leading to significant delays in rescue operations. Past catastrophic events, such as the Uttarakhand Flood and the Indian Ocean Earthquake, illustrate the dire consequences of inadequate communication systems and highlight the necessity for a reliable framework that can facilitate immediate assistance. The EMS is designed to operate in various emergency scenarios, including fires, medical emergencies, accidents, and natural disasters like earthquakes and floods. It enables users to report incidents and share their precise location coordinates via Wi-Fi, ensuring that help can be dispatched promptly. The report critiques existing emergency response systems in India, such as the 1-0-8 and 1-0-0 services, which provide integrated emergency services but suffer from significant limitations, including slow response times, a lack of GPS integration, and the absence of a unified emergency number system, leading to confusion and inefficiency during critical situations. it relies heavily on social media for reporting emergencies, which can delay rescue operations and spread misinformation. In contrast, the EMS aims to overcome these shortcomings by utilizing GPS technology for accurate location tracking. It allows for the generation of detailed reports based on various criteria such as area, issue type, and priority, facilitating better resource allocation during emergencies. Past catastrophic events, such as the Uttarakhand Flood and the Indian Ocean Earthquake, illustrate the dire consequences of inadequate communication systems and highlight the necessity for a reliable framework that can facilitate immediate assistance. The EMS is designed to operate in various emergency scenarios, including fires, medical emergencies, accidents, and natural disasters like earthquakes and floods. It enables users to report incidents and share their precise location coordinates via Wi-Fi, ensuring that help can be dispatched promptly.

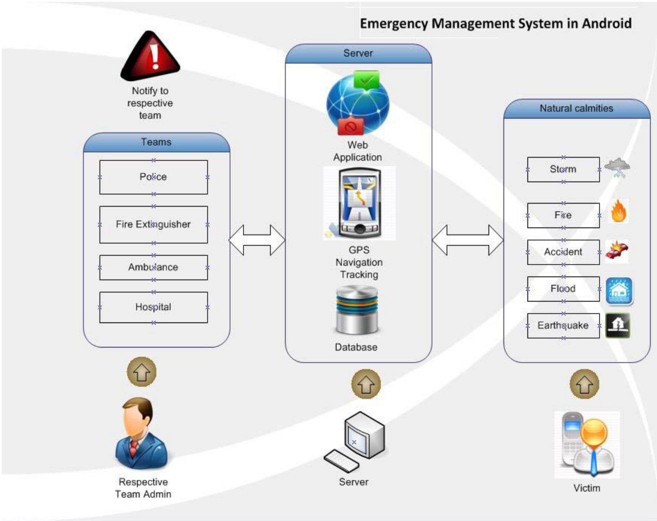

Figure 2: Architecture of EMS proposed by Rehka Jadhav, Jwalant Patel, Darshan Jain, and Suyash Phadhtare (IJCSIT)

The architecture of the EMS consists of a web server and a smartphone application that operates in two modes: network mode and GPS mode. The user application enables individuals to report emergencies by providing essential details, including the nature of the issue and their current location. This information is transmitted to the server, which responds with relevant emergency contact numbers and resources. The admin application allows authorized personnel to receive notifications about emergencies, view user details, and access optimal routes on Google Maps to reach victims quickly. Additionally, a web-based application is available for generating comprehensive reports on emergency incidents, categorized by area, priority, and location, aiding in the analysis and improvement of emergency response strategies. Future enhancements for the EMS include the implementation of ad-hoc networking techniques and the potential integration of cloud computing capabilities, which would expand the system's reach and accessibility beyond local networks, improving overall efficiency in emergency management. The report emphasizes the EMS's potential to revolutionize emergency communication in India, providing a structured and efficient response mechanism that can significantly improve rescue operations during disasters, ultimately aiming to save lives and enhance the effectiveness of disaster management efforts. The detailed exploration of the EMS's features, architecture, and future prospects underscores its importance in addressing the pressing need for reliable communication systems in emergency situations.

2.3 Escalating post-disaster rescue missions through ad-hoc victim localization exploiting Wi-Fi networks

It presents a comprehensive analysis of an innovative victim localization system called VLoc (Victim Localization), designed to enhance post-disaster rescue missions by utilizing existing Wi-Fi networks. This system is particularly relevant in the Global South, where traditional emergency response infrastructures are often inadequate. The rising number of disaster-related incidents in Bangladesh has resulted in thousands of casualties and significant economic losses, highlighting the urgent need for rapid and effective victim localization to mitigate these impacts. Conventional victim localization methods typically require pre-established infrastructure, which is often impractical in the chaotic aftermath of disasters. The VLoc system proposes a novel ad-hoc approach that operates independently of such infrastructure. It leverages the widespread use of smartphones by sending an SMS from emergency responders to victims' phones, prompting them to switch to Wi-Fi hotspot mode. This allows rescuers to measure the Received Signal Strength Indicator (RSSI) from these devices, which is then used to estimate the victims' locations through trilateration or multilateration techniques, calculating distances from multiple reference points based on the RSSI values. Extensive experiments were conducted across ten different testbeds simulating various disaster scenarios, including environments with structural damage, fire hazards, and normal office settings, to evaluate the system's performance. The results indicated a promising average localization error of 0.82 meters and response times averaging around 6.9 minutes, demonstrating the system's effectiveness in real-world applications. The design of VLoc emphasizes energy efficiency and minimal resource utilization, as well as adaptability to different smartphone models and Wi-Fi transmission power levels. The impact of rescuer positioning on localization accuracy is also considered, with optimal positioning being crucial for minimizing errors. Additionally, a national policy could facilitate the implementation of such technologies by ensuring that victims' contact information is readily available to rescuers. The study advocates for further research into real-life applications of VLoc, including the potential for automated data collection and the exploration of victim localization in multi-floor or underground scenarios. This research significantly contributes to the field of emergency response and victim localization in disaster-affected areas. The development of the VLoc system represents a significant advancement in disaster response technology, particularly in regions where traditional emergency infrastructure is either lacking or severely compromised. One of the key advantages of VLoc is its ability to function without reliance on external communication networks, which are often rendered inoperable during disasters. By utilizing an ad-hoc approach that capitalizes on the widespread availability of smartphones, the system ensures that victims can be located quickly and accurately, even in the most challenging conditions. This innovation is particularly crucial for densely populated and disaster-prone regions such as Bangladesh, where rapid urbanization and environmental vulnerabilities have exacerbated the frequency and impact of natural disasters. The ability to achieve an average localization error of just 0.82 meters highlights the system's precision, making it a highly reliable tool for emergency responders seeking to navigate collapsed buildings, fire-ravaged areas, or flooded zones in search of survivors.

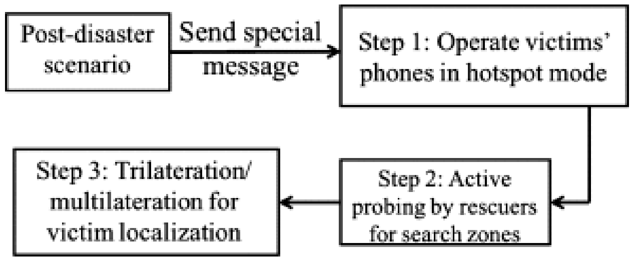

Figure 3: Functional overview of VLoc proposed by Taslim Arefin Khan, Tarik Reza Toha, Saiful Islam Salim, Md Toki Tahmid, and A.B.M. Alim Al Islam (Heliyon)

2.4 Emergency Accident Alert Mobile Application

The development and usability assessment of a mobile application designed to facilitate the reporting of road accidents to emergency response teams. It highlights the alarming statistics surrounding road accidents, noting that approximately 1.3 million people die annually due to such incidents, with many more suffering serious injuries. The critical role of accurate and timely information in emergency response situations is emphasized, as the effectiveness of emergency response teams (ERTs) heavily relies on the quality of information provided by bystanders or eyewitnesses during an emergency call. To address the communication barriers that often hinder effective emergency response, a mobile application was developed to allow users to send precise alerts and notifications about accidents directly to emergency call centers. The application was created using a Rapid Application Development (RAD) strategy, employing technologies such as PhoneGap, HTML, CSS, JavaScript, and jQuery. Usability of the application was assessed through a questionnaire survey involving 35 respondents, focusing on their acceptance of the app in relation to ten established usability principles. The findings indicate that the Emergency Accident Alert mobile application successfully integrates these usability principles, enabling users to report accidents with accurate details, including the condition of victims. Usability testing revealed positive feedback from users, who found the application to be useful, easy to navigate, and compliant with usability standards. The application can significantly enhance the speed and accuracy of emergency reporting, thereby improving the overall response time of emergency services. This system is particularly relevant in the Global South, where traditional emergency response infrastructures are often inadequate. The rising number of disaster-related incidents in Bangladesh has resulted in thousands of casualties and significant economic losses, highlighting the urgent need for rapid and effective victim localization to mitigate these impacts. Conventional victim localization methods typically require pre-established infrastructure, which is often impractical in the chaotic aftermath of disasters The existing emergency response systems in Malaysia, which include the fire and rescue services, police, and ambulance services. It highlights challenges faced by emergency operators, such as miscommunication and the stress of managing multiple tasks during emergencies. The mobile application is proposed as a solution to mitigate these issues by providing a more efficient means of communication, allowing bystanders to relay critical information quickly and clearly. In terms of methodology, the development phases of the application are outlined, which include requirements planning, user design, construction, and cutover phases. The image represents a conceptual diagram of an emergency communication system where bystanders use their mobile phones to send distress signals or emergency reports to a centralized database. The "Emergency Call Operator Database" collects and stores these incoming messages from multiple sources. The emergency call operator, using a desktop computer, retrieves and processes the information to coordinate an appropriate response. This system enhances emergency response efforts by ensuring real-time communication between bystanders and emergency services, allowing authorities to quickly assess situations and deploy assistance where needed. Such a system is particularly useful in disaster scenarios where immediate communication can help save lives and optimize resource allocation. By leveraging mobile technology, this framework improves accessibility and efficiency in handling emergency situations.

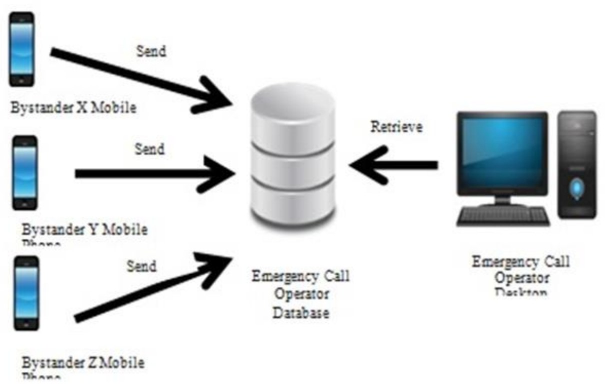

Figure 4: System architecture of emergency accident alert proposed by Aliza Sarlan, Wan Fatimah Wan Ahmad, Rohiza Ahmad, and Nurliyana Roslan (2016).

The system architecture involves users submitting accident details that are stored in a database accessible to emergency call operators. The application requires users to enter their identification details to prevent misuse, ensuring that only genuine reports are submitted. The usability assessment section elaborates on the ten usability heuristics that guided the application's design. These principles include visibility of system status, match between system and real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, help users recognize, diagnose, and recover from errors, and help documentation. The results of the usability testing are presented in detail, showing that the majority of respondents had a positive experience with the application, although some areas for improvement were identified, such as the need for an emergency exit button and enhanced visual aids. In conclusion, the Emergency Accident Alert mobile application represents a significant advancement in leveraging technology to improve emergency response systems. The importance of ongoing research and development in this field is emphasized, suggesting future enhancements to include automated verification of emergency reports to ensure their authenticity. The support of educational institutions in funding research efforts is also acknowledged, underscoring the collaborative effort involved in this project. The first action involves deploying the rescue teams to the emergency site to provide immediate assistance. Once the initial response is complete, the second action directs the emergency case to a hospital if medical attention is required. This structured approach ensures an efficient and timely emergency response, allowing for the rapid mobilization of resources to handle various crisis situations. The flowchart highlights the importance of coordination between emergency services to minimize response time and maximize the chances of saving lives.

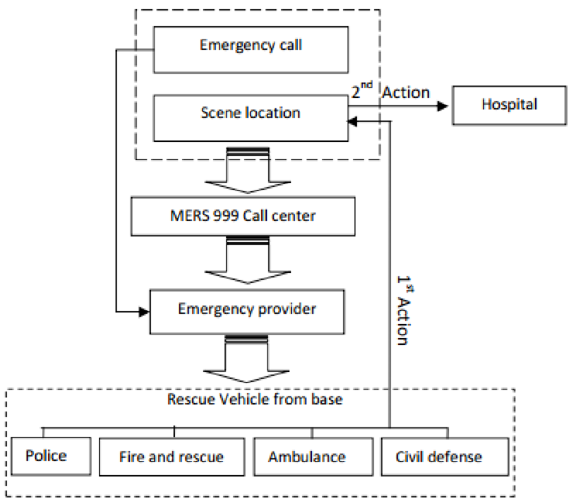

Figure 5: Flowchart of handling a road accident emergency proposed by Aliza Sarlan, Wan Fatimah Wan Ahmad, Rohiza Ahmad, and Nurliyana Roslan (2016).

2.5 RescueLink Pro: Pioneering Android App for Intuitive Emergency Helpline Services and Assistance

The Android application called RescueLink Pro, which is designed to enhance personal safety and security during emergencies. In an era where smartphones are integral to daily life, the application leverages the advanced features of these devices to provide users with a reliable means of alerting trusted contacts and authorities in critical situations. RescueLink Pro operates on a dual alert system consisting of two distinct types of alerts: Orange Alert and Red Alert. The Orange Alert is intended for situations where users feel unsafe but are not in immediate danger. When activated, this alert allows users to share their real-time location with designated emergency contacts, enabling quick assistance and coordination. This feature is particularly useful for individuals traveling in unfamiliar areas or facing uncertain circumstances, as it helps ensure that trusted contacts are aware of the user's situation and location. In contrast, the Red Alert is designed for critical emergencies that require immediate action. When a user activates the Red Alert, the application sends an urgent message to emergency contacts that includes the user's current location. Additionally, the app records audio of the surrounding environment, providing crucial context for responders. This feature is particularly valuable in life-threatening situations, as it allows emergency contacts to understand the nature of the emergency and respond accordingly. RescueLink Pro also integrates automated emergency response features to further enhance its reliability and efficiency. The application includes a timer-based distress signal, where users can set a timer when entering potentially unsafe environments. If the user does not deactivate the alert within the specified time, the app automatically sends an emergency notification with their last known location to designated contacts. This feature is particularly useful for solo travelers, late-night commuters, or individuals in high-risk areas. Additionally, RescueLink Pro supports voice-activated emergency triggers, enabling users to initiate alerts without physically accessing their phones—an essential functionality in situations where manual activation is not possible. The dual alert system enhances the application's effectiveness by allowing users to communicate their level of urgency clearly. Beyond the alert functionalities, RescueLink Pro includes several additional features aimed at improving user safety. One notable feature is the ability to record video footage during emergencies. This capability allows users to document incidents in real-time, which can serve as vital evidence for legal proceedings or personal records. To ensure secure access to personalized emergency contact information, users are required to create an account and log in to the application. This authentication process safeguards against unauthorized access and protects the integrity of the user's data and privacy. Once logged in, users can manage their emergency contacts and grant the necessary permissions for the app to function optimally. These permissions include access to location services, audio recording, and video recording capabilities. The methodology section of the paper outlines the user experience, detailing how individuals can create accounts, manage emergency contacts, and effectively utilize the app's features. This feature is particularly useful for individuals traveling in unfamiliar areas or facing uncertain circumstances, as it helps ensure that trusted contacts are aware of the user's situation and location. In contrast, the Red Alert is designed for critical emergencies that require immediate action. When a user activates the Red Alert, the application sends an urgent message to emergency contacts that includes the user's current location. Additionally, the app records audio of the surrounding environment, providing crucial context for responders. The flowchart illustrates the operational process of an emergency alert system, highlighting key functionalities aimed at enhancing user safety during critical situations. The process begins with a login step, allowing users to access their accounts securely. Following authentication, users can add emergency contacts, ensuring that alerts reach the right individuals when triggered. Once an emergency occurs, the system activates triggered alerts, leading to multiple simultaneous actions to maximize response effectiveness. The application sends an SMS containing vital emergency details to pre-designated contacts while also retrieving and sharing the user’s location for precise tracking.

Additionally, the system incorporates multimedia-based emergency responses, including audio and video recording to capture real-time evidence of the situation. These recordings provide crucial context for responders and legal purposes. Furthermore, the system activates a ringing alarm, which can serve to attract attention from nearby individuals or deter potential threats. All SMS alerts are dispatched to emergency contacts, ensuring a rapid response from trusted individuals or authorities. Finally, once the alert sequence is completed, the system allows for a secure exit, ensuring users can deactivate the emergency mode when necessary. This feature is particularly valuable in life-threatening situations, as it allows emergency contacts to understand the nature of the emergency and respond accordingly.

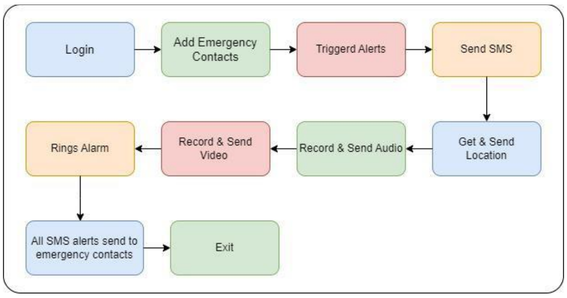

Figure 6: block diagram proposed by Prof. S. H. Sangale, Ishika Mahajan, Shashwati Aware, Gitanjali Gamane, and Dinah Khan (IJNRD).

The application prompts users to grant necessary permissions, ensuring that it can operate effectively in emergency situations. For instance, if the user's smartphone battery is low, the app proactively notifies the user and seeks permission to share their location for safety, demonstrating a design philosophy that prioritizes user safety and responsiveness. The literature survey included in the paper highlights existing research and applications related to emergency response systems. It emphasizes the need for a more user-friendly and efficient solution to address the shortcomings of current emergency response frameworks. Various studies have explored the integration of technology in emergency reporting and handling, showcasing the importance of real-time communication and evidence gathering in crisis situations. By situating RescueLink Pro within this broader context, the application is positioned as a potential game-changer in how individuals access emergency services and communicate during critical moments. In conclusion, RescueLink Pro represents a significant advancement in emergency management applications. It combines advanced technology with a user-centric design, focusing on enhancing individual safety, facilitating efficient communication, and gathering evidence during emergencies. The development and adoption of such innovative solutions are essential for empowering individuals and improving overall emergency response systems, ultimately contributing to a safer environment for all. The application not only addresses immediate needs in crisis situations but also emphasizes the importance of evidence collection, which can be crucial or legal and safety purposes.

2.6 Metanetwork Framework for Performance Analysis of Disaster Management System-of-Systems

The paper presents a comprehensive framework for analyzing the performance of disaster management systems, specifically focusing on the concept of disaster management as a system-of-systems (SoS). The primary goal is to address the inefficiencies that arise from the lack of integration among various heterogeneous systems and entities involved in disaster management. Effective disaster management is crucial for minimizing the adverse impacts of natural disasters on communities, and the authors emphasize that improved coordination and integration among these entities are essential for enhancing operational efficiency. The framework proposed in the study identifies five main entities that are critical to disaster management: stakeholders, operations, resources, information, and infrastructure. Stakeholders include various human entities such as government agencies, emergency responders, and the public. Operations refer to the tasks and activities directed by stakeholders to manage disaster situations. Resources encompass the physical assets required for disaster response, such as vehicles, equipment, and supplies. Information includes the plans, policies, and situational awareness necessary for effective decision-making. Infrastructure consists of the essential systems that support operations, such as transportation networks and utilities. To capture the interactions among these entities, a metanetwork framework is employed. This framework allows for the modeling of complex relationships and dependencies among the different types of entities involved in disaster management.

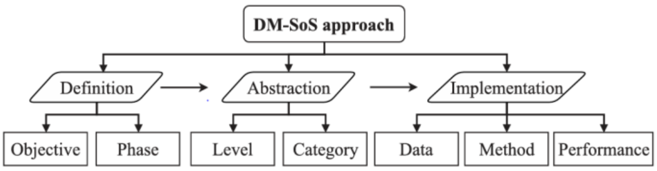

Figure 7: DM-SoS approach proposed by C. Fan and A. Mostafavi (IEEE).

The diagram represents the DM-SoS (Disaster Management System of Systems) approach, outlining a structured methodology for disaster management. The approach is divided into three primary stages: Definition, Abstraction, and Implementation, each with distinct components essential for effective disaster response and management.

The Definition phase establishes the fundamental framework by identifying key elements such as the objective of the system, the phases involved in disaster management, and other foundational aspects that guide the overall strategy. Once the definitions are set, the process moves to the Abstraction stage, where different levels and categories of disaster response are analyzed. This phase helps in structuring the system in a way that aligns with various disaster scenarios and operational requirements.

The final stage, Implementation, focuses on practical execution, including data management, the methods used for disaster response, and the performance evaluation of the system. By integrating these components, the DM-SoS approach ensures a comprehensive, well-structured disaster management system that enhances preparedness, response efficiency, and overall effectiveness in mitigating disaster impacts.

It measures of network efficiency, such as operational efficiency and coordination efficiency, to evaluate the effectiveness of system integration strategies. Operational efficiency is defined as the ability to complete disaster management operations based on the availability of necessary resources, information, and infrastructure. Coordination efficiency measures the level of collaboration and communication among stakeholders. The paper also explores the characteristics of disaster management as a system-of-systems. It defines a system-of-systems as a collection of independent systems that, when integrated, provide unique capabilities that exceed the sum of their individual contributions. This approach allows for a more holistic understanding of disaster management, as it considers the interdependencies and interactions among various systems. The authors highlight several distinguishing attributes of the system-of-systems approach, including the ability of individual systems to operate independently, the geographical distribution of systems, the evolutionary nature of systems that can change over time, and the emergence of behaviors resulting from interactions among heterogeneous entities. Disaster management is framed within four distinct phases: preparedness, response, recovery, and mitigation. Each phase has specific objectives and strategies, and the authors argue that understanding the temporal interdependencies among these phases is crucial for improving integration and coordination. The proposed framework consists of three dimensions of analysis: definition, abstraction, and implementation. The definition dimension establishes the boundaries of analysis by determining the objectives and phases of disaster management. The abstraction dimension identifies the categories of entities and their relationships at various levels, which can range from local to global. The implementation dimension involves data collection and modeling to assess performance based on the identified entities and their interactions.

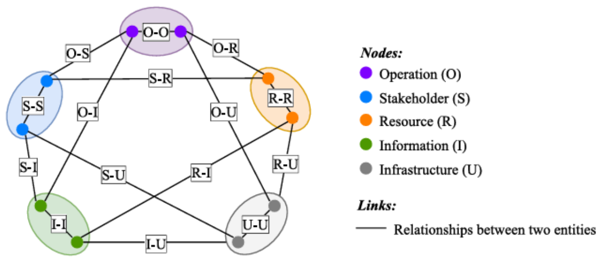

Figure 8: Metanetwork modeling of DM-SoS proposed by C. Fan and A. Mostafavi (IEEE).

The diagram represents a network-based model for disaster management, showcasing the interconnections between key entities involved in disaster response and recovery. The model consists of five primary nodes: Operation (O), Stakeholder (S), Resource (R), Information (I), and Infrastructure (U), each playing a crucial role in managing and mitigating disaster impacts. These nodes are linked by relationships, represented by black lines, illustrating the interaction between various components in the system. The metanetwork framework is structured into three main steps: specifying the metanetwork, formulating performance indicators, and evaluating performance. The first step involves modeling the entities and their relationships, which are organized into distinct networks. For example, stakeholder nodes and their relationships form a social network, while operation and resource nodes create an operation-resource network. The authors propose two quantitative indicators—operational efficiency and coordination efficiency—to assess the performance of disaster management processes. Operational efficiency is calculated based on the fraction of operations that can be completed given the availability of resources, information, and infrastructure. Coordination efficiency measures the degree of connections among stakeholder nodes. A case study of Hurricane Harvey is used to demonstrate the application of the proposed framework. Data is collected from official reports to map the metanetwork entities and relationships during the response and short-term recovery phases. The analysis identifies critical nodes within the metanetwork that significantly influence operational and coordination efficiency. For instance, the Texas Department of Transportation and FEMA are highlighted as crucial stakeholders whose removal would lead to substantial reductions in efficiency. The findings indicate that certain stakeholders play vital roles in maintaining network efficiency, and their absence can severely disrupt disaster management operations. The results of the case study reveal that the metanetwork is sensitive to the removal of critical nodes, which can lead to fragmentation and inefficiencies. The authors suggest that establishing communication channels and information-sharing systems among stakeholders can enhance coordination and operational efficiency. They also acknowledge the limitations of their study, such as the challenges in accurately mapping relationships between entities and the time-consuming nature of the process. Future research directions are proposed, including the development of automated techniques for entity identification and relationship mapping, which could improve the applicability of the metanetwork framework in various disaster management contexts. Overall, the framework provides a methodological approach for analyzing and improving the performance of disaster management systems through a system-of-systems perspective. It emphasizes the importance of understanding the complex interactions among diverse entities and the need for effective coordination and integration to enhance disaster response and recovery efforts. The insights gained from this research can inform the development of strategies to strengthen disaster management practices and improve resilience in the face of natural disasters.

2.7 Mobile Applications for Disaster Management

Disaster apps have a significant diversity in the type of information they provide and their intended target groups. The type of information vary based on type of disaster and the stage of disaster life cycle they focus on. The type of disaster can be a single disaster such as floods or may present information about multiple disasters in which case they are known as multi-hazard apps. The stages of a disaster life cycle are four fold according to disaster management literature. These are 'Preparation', 'Response', 'Recovery' and 'Mitigation'. The disaster apps can focus on one or many of these stages. The preparation stage involves information such as capacity building, monitoring and providing early warnings; the response stage involves information for evacuation, search and rescue; the recovery stage involves damage assessment and reconstruction; and lastly the mitigation stage involves information such as risk analysis and risk appraisals. The target groups can be the global community for international apps and local communities such as state, regional communities for local apps. Disaster apps are broadly classified into two categories: general purpose apps and built for purpose apps. General purpose apps include three sub-categories One-to-one, Oneto-many and Many-to-many. One-to-one refers to messaging apps such as Whatsapp and Wechat which are used by a person to send personal message to another. One-tomany refers to news apps are maintained by news agencies such as CNN and while publishing other news, they also publish disaster news to the public. Many-to-many include social media apps such as Twitter and Facebook. Out of these, people tend to favour familiar platforms such as social media which they have frequently used before the disaster occurrence. Additionally, the integration of cloud computing has enabled seamless access to disaster-related data, even in remote or infrastructure-compromised regions. Many disaster apps also offer multi-language support and accessibility features, ensuring that people with disabilities and non-native speakers can receive crucial information. Furthermore, some applications include mental health support resources, recognizing that disasters often lead to psychological distress. The development of these apps often involves collaborations between government agencies, NGOs, tech companies, and academic institutions, ensuring a holistic approach to disaster preparedness and response. However, disaster management authorities have concerns in promoting the use of general-purpose platforms for emergency situations is being explored for secure and transparent aid distribution, ensuring that financial and material assistance reaches the intended beneficiaries without corruption or mismanagement. As the world faces increasing climate-related disasters, continuous innovation in disaster apps is crucial for enhancing community resilience, minimizing loss, and improving overall disaster response effectiveness. as many issues arise such as privacy, information quantity, and content quality. Built for purpose apps are usually maintained by emergency agencies and will focus on functions such as Alert and information dissemination: disseminating authorised information before and during disasters; and Information collation: gathering, filtering and analysing data to build situation awareness. These apps are usually one-way; commonly originating from the authorities to the public. Examples of such apps are the American Red Cross Apps and the Federal Emergency Management Agency (FEMA) App, both of which were developed by their respective agencies.

2.8 Rescue Relief Agency Management For Disaster Recovery

It discusses the critical need for improved coordination among rescue agencies during disaster response efforts, emphasizing the challenges faced in the current landscape due to the absence of a centralized platform for communication and collaboration. This lack of a unified system often leads to duplicated efforts, inefficient resource allocation, and delays in providing aid to those in need. To address these challenges, the paper proposes the development of a comprehensive mobile application designed to serve as a central hub for rescue agencies. This application would enable agencies to register their information, including location, contact details, areas of expertise, and available resources. The data entry process could be manual or automated through GPS and other location tracking technologies, ensuring that the information is both comprehensive and up-to-date. The application would feature a user-friendly interface that visualizes the locations of registered rescue agencies on a map, allowing users to filter results based on specific criteria such as disaster type, available resources, or the time since the last reported activity. Beyond merely displaying agency locations, the application would facilitate communication and collaboration among rescue organizations. Agencies could send alerts or requests for assistance directly through the platform, allowing for better coordination and optimized resource utilization. The application would also support the sharing of critical resources, such as medical equipment and transportation, ensuring that these resources are deployed where they are most needed. The potential of this mobile application to revolutionize disaster response is highlighted, as it would provide a centralized platform for communication, collaboration, and resource management, ultimately saving lives and minimizing the impact of disasters. The paper includes a literature survey that reviews existing research on the use of technology in disaster management. It references various studies exploring the advantages and challenges of leveraging technology for emergency response, including mobile cloud computing, cloud-based disaster management systems, and the use of Internet rescue robots. These studies underscore the importance of technology in enhancing coordination, response times, and resource allocation during disasters. The methodology for developing the application is outlined in detail, encompassing several key steps. It begins with a requirements analysis involving engagement with stakeholders to gather specific needs. This is followed by database design, where a central database is created to store agency information. The importance of data entry methods, user interface design, and the integration of location tracking technologies is emphasized. Communication features are also highlighted, allowing agencies to send alerts and collaborate effectively. Security and privacy considerations are paramount, with strong authentication and encryption measures proposed to protect sensitive data. The results and discussion section illustrates how the application serves as a crucial bridge between those in need and rescue teams. Users can report disasters through an intuitive interface, providing detailed information and photo evidence. The application allows agency administrators to manage incoming requests efficiently, streamlining resource allocation based on urgency and severity. The ability to transfer requests between agencies fosters collaboration and mutual aid, enabling a more coordinated response to emergencies. In conclusion, the development of this application represents a significant advancement in disaster response operations. To address these challenges, the paper proposes the development of a comprehensive mobile application designed to serve as a central hub for rescue agencies. This application would enable agencies to register their information, including location, contact details, areas of expertise, and available resources. The data entry process could be manual or automated through GPS and other location tracking technologies, ensuring that the information is both comprehensive and up-to-date. 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The paper advocates for the development of a centralized database for rescue agencies as a vital step toward improving disaster response and fostering a culture of collaboration among agencies.

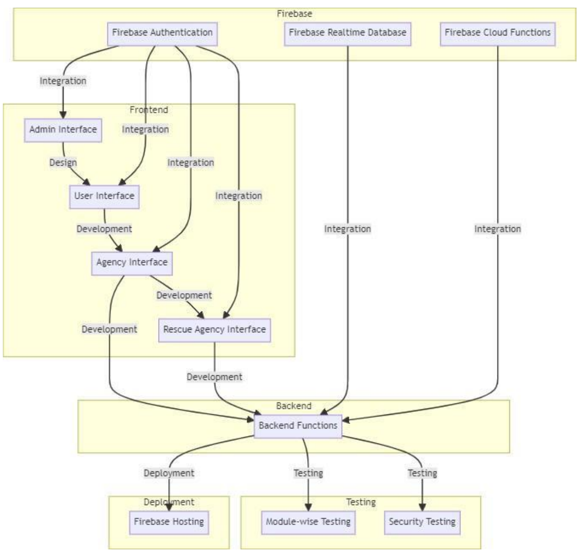

Figure 9: System Architecture proposed by Dr. Bhanumathi S, Palavali Harsha Sai, Rakesh N, Tribhuvan K S, and Uday Kiran H S (IJARSCT).

The diagram represents the architecture of a disaster management system built on Firebase, showcasing various components and their integration within the system. It consists of three main layers: Frontend, Backend, and Deployment/Testing. The Frontend layer includes different user interfaces such as the Admin Interface, User Interface, Agency Interface, and Rescue Agency Interface, which are designed and developed separately before being integrated. These interfaces ensure accessibility for different stakeholders, including emergency responders, administrators, and the general public.

The Backend layer consists of Firebase Authentication, Firebase Realtime Database, and Firebase Cloud Functions, which handle user authentication, real-time data management, and cloud-based automation of processes, respectively. The backend integrates with all frontend components, ensuring seamless data flow and functionality. In the Deployment and Testing layer, the system undergoes module-wise testing, security testing, and integration testing to ensure its robustness before deployment via Firebase Hosting. The architecture highlights the importance of real-time communication, data security, and efficient cloud-based operations in disaster management applications, ensuring reliability during emergency situations.

3. Existing System

The existing disaster management systems rely heavily on manual reporting, traditional communication channels like phone calls, radio broadcasts, and local authorities, which often lead to significant delays in response times. These systems lack centralized platforms to collect and process real-time information, causing inefficient coordination and resource allocation. Additionally, they depend on fragmented and outdated methods that are slow to relay critical updates to response teams.

Some modern systems attempt to gather disaster-related information from social media platforms and news portals to detect and analyze emergencies. While this method provides rapid updates, it is prone to misinformation and lacks reliability, as social media content may not always be accurate or verified. Furthermore, these systems often struggle to process and filter large amounts of unstructured data, which can delay decision-making during critical situations.

Existing systems also lack features like real-time GPS tracking to pinpoint victim locations accurately. Without automated mechanisms, rescue teams rely on incomplete or ambiguous information, delaying their response. Victims are not able to specify critical needs such as rescue assistance, food, water, or medical supplies, leading to mismanagement of resources and inefficient relief efforts.

Moreover, the absence of multi-channel alert mechanisms limits the ability of existing disaster management systems to disseminate urgent warnings effectively. Many systems still rely on a single mode of communication, such as SMS or radio broadcasts, which may not reach all affected individuals in time. A more robust system should integrate multiple communication channels, including push notifications, automated calls, satellite messaging, and IoT-enabled sirens to ensure comprehensive coverage.

Additionally, most current systems lack interoperability, making it difficult for different emergency agencies and relief organizations to share critical data in real time. Without a unified and standardized platform, coordination between government agencies, NGOs, and local responders remains fragmented, leading to delays, resource misallocation, and duplication of efforts. A more advanced system should incorporate cloud-based solutions and AI-driven analytics to process incoming data efficiently and provide actionable insights to decision-makers.

Another pressing issue is the lack of user engagement and preparedness measures in existing systems. Most applications and platforms focus solely on response and recovery, neglecting proactive disaster preparedness efforts. Features like personalized risk assessments, evacuation planning, emergency drills, and AI-driven hazard forecasting could significantly improve disaster readiness and resilience among communities. Furthermore, incorporating machine learning algorithms to analyze past disaster patterns and predict future risks would allow authorities to take preventive action rather than merely reacting to crises.This would enable faster, more coordinated, and more effective disaster response strategies, ultimately saving more lives and reducing economic losses.

Another significant limitation is the network dependency of these systems, which renders them ineffective in remote areas or regions where communication infrastructure is damaged during disasters. Offline functionalities or low-bandwidth communication are often missing, restricting their usability in critical situations. Additionally, current systems lack integration with technologies like sensor networks or predictive analytics, which could proactively detect disaster risks such as floods, fires, or earthquakes.

App feature categorisation and number of apps

Category	Feature	No. of Apps
Preparation	Early Warning Alerts	10
	Disaster Forecasting	7
	Prep Tips/Tutorials	8
Response	Real Time Alerts	30
	Disaster Maps	21
	Real-Time Tracking	6
	Emergency Reporting	1
Recovery	Disaster Updates	26
	News/Bulletins	8
	Share Experiences	3
	Safety Confirmation	3
Mitigation	Help/Shelter Info	7
	Recommendation Actions	2

3.1 Limitations of existing system

give me some more lines Communication in emergency situations is also limited by the dependency on landlines and SMS, which restrict the flexibility of the communication channels, especially in areas where networks are damaged or overloaded. This dependency on outdated communication methods can create bottlenecks, preventing the timely flow of crucial information between victims, responders, and other involved parties. Furthermore, the lack of detailed, real-time information leads to the misallocation of resources. Rescue teams often do not have access to up-to-date data regarding the number of people needing assistance, the nature of the disaster, or the specific resources required, which can lead to inefficiencies in how aid is distributed. The absence of visual data, such as images or videos, exacerbates this issue, as responders do not have an accurate view of the incident, making it harder to assess the severity of the situation and plan appropriate responses. Another major limitation is the system's scalability. Traditional emergency response systems struggle to handle larger-scale or multi-region disasters, as they are not equipped to manage the influx of data or coordinate efforts across wide geographic areas. This makes it difficult to provide a coordinated response during widespread events like hurricanes, wildfires, or large-scale earthquakes.

Moreover, the lack of automation and intelligent prioritization in existing disaster management systems further hampers their efficiency. Many current platforms rely on manual data entry and decision-making, which can slow down response times. By integrating AI-driven analytics and automation, emergency systems could prioritize high-risk areas, allocate resources dynamically, and predict the best response strategies based on real-time conditions.

Another critical issue is the limited use of crowdsourced data from affected individuals. Many disaster response systems fail to leverage information from the people directly impacted by the crisis. Crowdsourced reports, combined with geotagged images and videos, could provide real-time situational awareness, enabling responders to assess damage levels, identify critical areas, and adjust rescue strategies accordingly. Implementing chatbots or AI-powered reporting tools could allow individuals to submit structured incident reports, making it easier for authorities to process large volumes of incoming data. Additionally, disaster management systems often lack multilingual support, which can be a major barrier in diverse communities. In multilingual regions, failure to provide alerts and instructions in multiple languages can lead to confusion and delays in evacuation efforts. Automated translation services and voice-based AI assistants could help ensure that emergency messages are accessible to a broader audience.

Furthermore, there is a significant gap in post-disaster coordination and recovery management. Most systems focus on the immediate response phase but fail to provide sustained support for rebuilding efforts, long-term aid distribution, and psychological assistance for victims. Implementing blockchain-based donation tracking, digital identity verification for displaced individuals, and AI-driven resource allocation could greatly improve post-disaster recovery operations.To build a truly resilient and adaptive disaster management system, future solutions must incorporate advanced technologies such as AI, IoT, blockchain, satellite communication, and cloud computing. These innovations would not only streamline emergency response efforts but also enhance early warning capabilities, resource distribution, and long-term recovery planning, making disaster response more proactive, coordinated, and effective.

Moreover, there is a significant gap in real-time communication between stakeholders, including victims, responders, and relevant agencies. This lack of efficient communication channels can lead to delays in decision-making, as critical updates or changes in the situation may not be communicated promptly. Additionally, most existing systems do not integrate with modern technologies such as the Internet of Things (IoT) or predictive analytics, which could significantly enhance early disaster detection and help predict potential risks before they escalate. The absence of these technologies prevents the system from proactively addressing disasters, relying instead on reactive measures. . In multilingual regions, failure to provide alerts and instructions in multiple languages can lead to confusion and delays in evacuation efforts. Automated translation services and voice-based AI assistants could help ensure that emergency messages are accessible to a broader audience. Furthermore, there is a significant gap in post-disaster coordination and recovery management. Most systems focus on the immediate response phase but fail to provide sustained support for rebuilding efforts, long-term aid distribution, and psychological assistance for victims. Implementing blockchain-based donation tracking, digital identity verification for displaced individuals, and AI-driven resource allocation could greatly improve post-disaster recovery operations.To build a truly resilient and adaptive disaster management system, future solutions must incorporate advanced technologies such as AI, IoT, blockchain, satellite communication, and cloud computing. These innovations would not only streamline emergency response efforts but also enhance early warning capabilities, resource distribution, and long-term recovery planning, making disaster response more proactive, coordinated, and effective.

Furthermore, existing systems struggle with managing large volumes of unstructured data, such as information from social media or open-source platforms. This inability to process and analyze such data slows down decision-making and impedes timely and informed responses. Finally, limited user accessibility and engagement remain a major barrier to the effectiveness of emergency response systems. Many people, especially those in remote or underserved regions, may not have access to the necessary technology or may not be familiar with how to use the system, which can reduce the overall participation in reporting and receiving vital emergency information. These limitations collectively prevent emergency response systems from functioning at their full potential, resulting in slower and less effective disaster management efforts.

4. Literature Survey

[1] Hawkar Jabbar H. Ali and Karwan Jacksi proposed an automated early alert system for natural disaster risk reduction aimed at minimizing the devastating effects of natural disasters. The authors emphasized leveraging mobile technology to notify users about potential risks in advance, focusing primarily on weather-related disasters such as storms, floods, and hurricanes. One of the key strengths of this approach is its multi-channel alert mechanism, which combines push notifications, SMS alerts, and voice messages to ensure that warnings reach a wide range of users, including those with limited internet access. Moreover, the system can be tailored to provide localized alerts, ensuring that only individuals in affected areas receive relevant warnings, thereby reducing panic and misinformation. The proposed system integrates meteorological data to predict and monitor environmental conditions, ensuring timely and accurate warnings. This framework relies on mobile applications and SMS technology to deliver real-time notifications to individuals, enabling them to take proactive safety measures. the system is designed to be scalable and adaptable, allowing it to integrate with government disaster management agencies, humanitarian organizations, and first responders. This ensures a coordinated emergency response and facilitates efficient resource allocation in affected areas. By combining technology-driven forecasting, automated alerts, and user-centric safety tools, this system represents a significant advancement in disaster risk reduction and community resilience. The system's ability to provide alerts helps reduce the loss of life and property damage, particularly in vulnerable regions.

[2] Shin-Yan Chiou and Zhen-Yuan Liao proposed a real-time, automated, and privacy-preserving mobile emergency-medical-service network to address the urgent need for rapid emergency response in critical situations. Their system focuses on informing the closest available rescuer to quickly assist victims in need of emergency support. The proposed framework leverages mobile communication, GPS tracking, and secure data transmission to identify the exact location of the victim and notify nearby responders. One of the standout features of this system is its emphasis on privacy preservation through the use of encryption methods to protect sensitive data, such as the location and personal information of both victims and rescuers. To further enhance efficiency, the system integrates with hospital networks and emergency services, enabling seamless coordination between first responders, paramedics, and healthcare facilities. This ensures that medical teams are pre-alerted about incoming patients, allowing them to prepare the necessary resources and equipment in advance.

Another key aspect of the framework is its multi-modal communication approach, which includes mobile notifications, SMS alerts, and voice-assisted guidance to ensure accessibility, even in areas with limited internet connectivity. The system also supports wearable medical devices, allowing real-time health data transmission from victims to responders, further improving the accuracy of medical assessments.The authors designed the system to optimize response times by automatically selecting the nearest rescuer based on proximity and availability, which is particularly critical for medical emergencies where every second counts.

[3] Deepshikha Sarma, Amrit Das, Pankaj Dutta, and Uttam Kumar Bera proposed a cost-minimization resource allocation model for disaster relief operations**,** employing a multi-criteria decision-making (MCDM) approach with the integration of information crowdsourcing. This model is designed to optimize the allocation of critical resources—such as food, water, medical supplies, and shelter—during disaster relief operations. the model incorporates geo-spatial analysis to enhance logistical planning, ensuring that relief supplies are delivered to the most affected areas with minimal delays. By integrating real-time GPS tracking, the system continuously monitors the movement of relief shipments, allowing authorities to adjust routes dynamically in response to changing disaster conditions, such as blocked roads or emerging hotspots of distress. To further improve decision-making, the framework employs machine learning algorithms that analyze historical disaster data and ongoing crisis reports to predict resource demand trends. This predictive capability helps humanitarian agencies pre-position essential supplies in strategic locations before a disaster strikes, enhancing preparedness and response efficiency. The authors introduced a framework that prioritizes demands based on urgency, location, and resource availability, ensuring that critical needs are met efficiently while minimizing costs. The use of crowdsourced data allows the system to collect real-time inputs from affected communities, which are then processed using decision analytics to determine optimal resource distribution. By leveraging MCDM techniques, the model evaluates multiple criteria, such as resource priority, transportation costs, and location constraints, to deliver the most efficient relief solutions.

[4] Kirtan Gopal Panda, Shrayan Das, Debarati Sen, and Wasim Arif proposed a UAV-aided emergency communication network for post-disaster scenarios, addressing the challenges of communication failures due to damaged infrastructure. The authors designed a system that deploys Unmanned Aerial Vehicles (UAVs) equipped with Wi-Fi nodes to establish temporary communication networks in disaster-struck areas. The UAVs serve as airborne routers that provide connectivity for victims, rescuers, and disaster response teams, enabling effective communication even when terrestrial networks fail. To improve energy efficiency and operational longevity, the UAVs are equipped with solar panels and intelligent power management systems, enabling prolonged flight times and reducing dependency on frequent battery replacements. The authors also introduce edge computing capabilities in the UAVs, allowing them to process data locally before transmitting critical information to command centers. This feature reduces network congestion and enhances response times for emergency alerts.

Additionally, the system incorporates AI-driven predictive analytics to map victim locations and detect areas with high distress signals based on aggregated data from mobile devices, wearables, and sensors

The system also integrates real-time surveillance cameras on the UAVs, providing live video feeds of affected zones to assist authorities in assessing damage and prioritizing rescue operations. This dual functionality—communication and surveillance—enhances situational awareness and facilitates better resource allocation in post-disaster management.

[5] Areej Alshutayria, Nahla Aljojo, Basma Alharbia, Ameen Banjar, Atheer Alshehri, Mashaiel Alargoubi, Ola Barradah, and Rahaf Helabi proposed an interactive mobile application aimed at addressing the challenges faced by injured individuals in need of immediate assistance by connecting them with the nearest first aiders. This innovative system uses a centralized platform that integrates GPS-based location tracking, real-time communication, and route optimization to ensure that first aiders can quickly locate victims and provide timely support. The application allows injured individuals or bystanders to send distress signals through the mobile interface, and the system identifies the nearest trained first aider based on location proximity. Once the signal is received, the first aider can access the victim's location and optimize their route to reach the injured individual efficiently. The proposed method focuses on reducing emergency response time and empowering bystanders to play a critical role in saving lives before professional medical assistance arrives. The system also includes features such as user verification and a streamlined communication channel to ensure reliability and trustworthiness in connecting victims with aiders.

[6] Aliza Sarlan, Wan Fatimah Wan Ahmad, Rohiza Ahmad, and Nurliyana Roslan proposed an **Emergency Accident Alert Mobile Application** designed to revolutionize the way emergency accidents are reported and managed. This mobile application allows eyewitnesses or bystanders to send real-time accident alerts to Emergency Response Teams (ERTs)**,** providing accurate and essential details such as the accident's location and the number of victims involved. Developed using Rapid Application Development (RAD) methodology and tools such as PhoneGap, the system focuses on fast deployment and cross-platform compatibility, ensuring it can function effectively on both Android and iOS devices. The application improves accident reporting by enabling users to input information quickly and share it with the nearest responders, significantly reducing response time and ensuring timely medical intervention. The proposed system also incorporates location-based tracking using GPS technology to provide responders with precise coordinates of the accident site, eliminating the delays caused by ambiguous information.

[7] Xu, L.D., Cai, H., Xie, C., Hu, J., and Bu, F. proposed a robust and innovative IoT-based framework for emergency medical services that enables real-time monitoring, data collection, and communication between patients and healthcare providers. The authors introduced an advanced system that integrates data from multiple IoT-enabled sensors, such as health monitors, to continuously track critical health parameters like heart rate, temperature, and blood pressure. This data is transmitted in real-time to healthcare service providers, who can analyze the information and respond immediately in case of medical emergencies. The proposed framework focuses on providing ubiquitous data access, ensuring that patients, healthcare professionals, and emergency responders can securely access health information anytime and anywhere. By leveraging sensor fusion, the system minimizes latency and optimizes the transmission of data, enabling healthcare personnel to make quick and informed decisions.

[8] Fan, C., and Mostafavi, A. proposed a Metanetwork Framework for the performance analysis of Disaster Management System-of-Systems (DM-SoS)**,** addressing the complexities of coordination among multiple stakeholders, operations, and resources during disaster response. The framework analyzes critical entities, their interdependencies, and their roles within a disaster management system by leveraging network analysis tools. It integrates various subsystems, including response agencies, infrastructure, and resource allocation units, to evaluate the overall system performance and identify bottlenecks that hinder operational efficiency. The authors designed performance metrics such as operational efficiency and coordination effectiveness**,** which are used to quantify the system's capabilities under dynamic disaster scenarios. By creating a network-centric approach, the framework enables disaster management agencies to assess the impact of individual entities and their interactions, ultimately improving decision-making and response times. This method is particularly effective in identifying critical failure points and enhancing resilience within a multi-agency disaster management system. The authors demonstrated that the framework provides a holistic and scalable solution for analyzing large-scale systems and their performance under stress.

[9] **Lidres, K. A., Sadava, D. J. G., and Soberano, K. T.** proposed RescueLink**,** an **SOS** Alert System for disaster response and management that connects affected users with rescue personnel using real-time GPS tracking and seamless communication tools. This system focuses on enabling individuals in disaster-struck areas to send emergency signals to nearby response teams via a web and mobile-based application. Users can initiate alerts by pressing a dedicated SOS button, which triggers the application to share their precise GPS coordinates and personal details with rescue teams. The system also supports push notifications to ensure that emergency personnel receive timely updates and can efficiently coordinate rescue operations. To improve usability, the authors incorporated a user-friendly interface that simplifies the reporting process for users of all technical levels. RescueLink facilitates two-way communication between users and disaster management teams, ensuring that responders can gather additional information about the user's condition and needs.

[10] **Dave, R. K.** proposed a comprehensive study on the role of media in disaster management**,** emphasizing its critical role in disaster preparedness, mitigation, and response. The study highlights that both electronic media (television, radio, and online platforms) and print media (newspapers and magazines) play a vital role in disseminating critical information to the public during disasters. Media platforms serve as a bridge between disaster management authorities and affected communities by providing timely alerts, such as weather warnings, evacuation notices, and updates on resource availability. In addition to emergency communication, the media also focuses on raising public awareness about disaster preparedness, safety measures, and long-term recovery strategies. The study further examines the role of media in mobilizing resources and fpublic support during disaster recovery, including fundraising and relief campaigns. However, the author identifies key challenges, such as the risk of misinformation or sensationalized reporting, which can lead to public panic and confusion. Additionally, media coverage may not effectively reach remote or underserved areas with limited access to broadcast and digital platforms.

[11] **Sundaresan, R., Ajay, A., Hariharan, S., and Yuvalatha, S.** proposed a Flutter-based women safety application aimed at improving the security and emergency response for women in distress. This mobile application integrates SOS alert mechanisms**,** live GPS location tracking**,** and emergency notifications to address critical safety concerns. Users can activate the emergency feature through a simple interface or shake-to-activate functionality, ensuring quick access during dangerous situations. Upon activation, the

application sends real-time location updates and an SOS message to trusted contacts, including family members or nearby police authorities. The authors incorporated a continuous tracking system that periodically shares the user's live location, enabling responders to follow their movements until the alert is deactivated. The application also features a community support network, where users can share safety advice and collaborate to create a safer environment for women.

5. Conclusion

The proposed application provides an efficient and real-time solution for disaster management, enabling users to quickly report emergencies such as floods, fires, and earthquakes through a structured and user-friendly interface. By allowing victims to specify their critical needs—such as the number of people needing rescue, food, water, or medical supplies—the platform ensures that clear and actionable information is available to response teams. Integrated GPS-based location tracking further enhances the system's capability to deliver accurate and precise location data, allowing disaster response teams to act swiftly and reach the affected areas with minimal delays. The real-time nature of the system ensures rapid communication between victims and the nearest rescue teams, facilitating quick decision-making and efficient resource allocation. Moreover, the proposed application incorporates multi-channel communication, including push notifications, SMS alerts, and in-app messaging, to ensure that critical information reaches users even in areas with limited internet connectivity. This redundancy enhances reliability during crises, ensuring that victims can request help even when traditional networks are congested or compromised.

To further enhance usability, the system features a multi-language interface, making it accessible to diverse populations and ensuring that language barriers do not hinder emergency communication. Additionally, voice command capabilities allow users to report incidents hands-free, which is particularly beneficial for individuals in distress or those with disabilities.

Another key feature is the integration of artificial intelligence (AI) and machine learning algorithms, which analyze historical disaster data, real-time reports, and environmental factors to generate predictive insights. This allows authorities to anticipate disaster-prone areas, identify high-risk zones, and pre-deploy resources in preparation for potential emergencies.

Furthermore, the application incorporates crowdsourced data collection, enabling users to report road blockages, infrastructure damage, or hazardous conditions. This collective intelligence helps rescue teams navigate efficiently, avoiding delays caused by impassable routes. The system also includes a volunteer coordination module, allowing trained individuals to register as emergency responders, further expanding the network of available assistance.

To ensure data security and privacy, the platform employs end-to-end encryption for all communications, protecting sensitive user information from unauthorized access. Additionally, cloud-based backup mechanisms ensure that vital data remains available, even in the event of local system failures.

By leveraging these advanced features, the application not only improves real-time disaster response but also strengthens overall disaster preparedness and resilience. Its holistic approach ensures that both short-term emergency relief and long-term risk mitigation strategies are effectively addressed, making it a comprehensive solution for modern disaster management. This capability significantly enhances the ability of agencies to reduce disaster impacts, save lives, and minimize property damage. The application's ability to address multiple types of disasters through predefined categories provides a unified solution, simplifying the process for both affected individuals and responders. The system also empowers users by enabling them to specify the exact kind of attention they require, ensuring that the most pressing needs are prioritized and addressed. By bridging the gap between victims and rescue agencies, the application enhances coordination, improves response efficiency, and promotes a more organized disaster management process. Overall, this project demonstrates the potential of technology to streamline emergency response operations, ensuring timely intervention and optimized resource utilization during crises. It effectively supports both disaster victims and response teams, contributing to a safer and more resilient society.

Future Work

The future scope of real-time emergency response platforms, presents several opportunities for advancement through emerging technologies. The integration of AI-driven predictive analytics will enable early detection of disaster patterns by analyzing historical climate data, sensor inputs, and social media trends, allowing for proactive disaster preparedness. By leveraging machine learning models, these systems can forecast potential high-risk zones, helping authorities deploy resources efficiently before a disaster strikes. The use of IoT sensors and edge computing will significantly enhance real-time monitoring of environmental factors such as seismic activity, flood levels, temperature fluctuations, and air quality, providing automated early warnings. Cloud-based architectures will improve the scalability of these platforms, ensuring rapid data processing and seamless accessibility across different geographical regions. The development of blockchain-based data management can also provide secure, tamper-proof record-keeping, ensuring transparency in resource distribution and emergency response efforts. Additionally, AI-powered chatbots and voice assistants can be incorporated into mobile applications to guide victims through emergency protocols, enabling automated SOS activation and real-time assistance. For large-scale disaster management, collaborations with government agencies, NGOs, and healthcare institutions will facilitate direct integration with emergency response networks, ensuring faster and more coordinated relief efforts. The future of real-time emergency response platforms will also see significant advancements in 5G and satellite-based communication technologies, ensuring seamless connectivity even in remote or disaster-stricken areas where traditional networks fail. These high-speed networks will enable low-latency data transmission, improving the efficiency of real-time video surveillance, drone operations, and live tracking of affected populations. Furthermore, augmented reality (AR) and virtual reality (VR) technologies could be integrated into training programs for disaster response teams, offering immersive simulations of emergency scenarios. These simulations can help first responders practice rescue operations in a controlled environment, improving their preparedness and decision-making skills. Another crucial area for development is smart wearables embedded with biometric sensors, which can monitor the vital signs of victims and rescue workers in real time. These devices could automatically transmit distress signals if abnormalities such as extreme dehydration, high heart rate, or respiratory distress are detected, allowing medical teams to prioritize assistance based on urgency. Additionally, automated supply chain management systems powered by AI will enhance the logistics of relief distribution, ensuring that food, water, and medical supplies reach the most affected regions without delays or resource wastage. By integrating real-time demand forecasting, authorities can dynamically adjust supply routes based on evolving disaster conditions. The adoption of robotics in disaster response will further revolutionize search-and-rescue missions, with AI-driven autonomous robots capable of navigating collapsed structures, detecting trapped individuals, and delivering essential supplies in hazardous environments where human responders may struggle to operate safely. Advanced UAV technology can also be explored for autonomous search-and-rescue operations, deploying drones equipped with thermal imaging cameras to locate survivors in hazardous conditions.

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