

Smart Breakdown Assistance System with Identity Replication & Location Intelligence

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Abstract- Roadside vehicle breakdowns often cause inconvenience, safety issues, and delays in assistance due to the absence of smart support systems. Traditional breakdown help relies mostly on manual communication and reactive service processes. This approach increases response times and reduces service efficiency. This paper introduces a Smart Breakdown Assistance System with Issue Identification and Location Intelligence to address these problems. The system identifies the type of vehicle issue during a breakdown and automatically captures the user's real-time location using map-based services. By using location information, the system finds the nearest available service center or technician and sends help quickly. This method significantly cuts down service delays, improves resource use, and boosts user safety. The system includes real-time tracking, automated request handling, and smart decision-making algorithms to ensure faster and more accurate service. It also features technician availability tracking, customer notification updates, and performance analysis to enhance overall service quality.

Index Terms- Smart Breakdown Assistance, Location Intelligence, Issue Identification, Real-Time Tracking, Automated Dispatch System, Vehicle Breakdown Management, GPS-Based Services, Intelligent Transportation Systems, Emergency Assistance, Service Optimization.

I. INTRODUCTION

The Smart Breakdown Assistance System with Identity Replication and Location Intelligence is a modern and efficient solution developed to assist vehicle users during unexpected breakdown situations. In today's fast-moving world, vehicle failures can occur at any time and place, leading to inconvenience, delays, and sometimes unsafe conditions. This paper aims to provide a reliable and

quick-response system that connects users with nearby service providers using advanced technologies.

The system integrates identity replication, which securely stores and manages user and vehicle information. This feature ensures that user data is readily available across the system, allowing faster request processing and seamless service experience. It eliminates the need for repeatedly entering details and enhances data consistency and security.

Another key component of the system is location intelligence. By using GPS and map-based services, the system can accurately detect the user's current location and identify the nearest available service centers or technicians. This significantly reduces response time and ensures that help reaches the user as quickly as possible. Additionally, the system can analyze location data to generate heatmaps, helping administrators understand high-demand areas and improve resource allocation.

II. LITERATURE REVIEW

The development of smart vehicle breakdown assistance systems has been widely explored in recent research, focusing on improving response time, user convenience, and service efficiency through modern technologies.

Several studies propose mobile-based roadside assistance systems that allow users to request help during vehicle breakdowns. The On-Road Vehicle Breakdown Assistance (ORVBA) system enables users to connect with nearby mechanics through a mobile application, providing features like

registration, location sharing, and service provider listing. This approach improves accessibility, especially in remote areas where immediate assistance is difficult to obtain.

Research also highlights the importance of location-based services (LBS) and GPS technology. Many systems utilize GPS to track user location in real time and identify nearby service providers, significantly reducing response time. Studies show that integrating mapping technologies and real-time tracking enhances efficiency and ensures faster service delivery. Additionally, systems such as Visit Mechanic use radius-based detection and notifications to connect users with mechanics quickly.

Another important contribution comes from systems that incorporate real-time communication and cloud technologies. Applications built using platforms like Firebase and cloud databases allow instant notifications, live tracking, and seamless interaction between users and technicians. These systems enable technicians to receive requests, accept them, and navigate directly to the user's location. Real-time communication has been shown to improve transparency and customer satisfaction in roadside assistance services.

Recent advancements also explore the use of IoT and intelligent transport systems (ITS). These technologies enable the collection of real-time data from sensors and support smart decision-making for vehicle assistance and road safety. Furthermore, digital platforms like ResQway integrate web-based services with GPS and IoT to create a more comprehensive roadside assistance ecosystem.

Despite these developments, existing systems often lack integration between identity management and location intelligence. Many applications focus either on location tracking or service connection but do not effectively manage user identity and data consistency across the system. The proposed system addresses this gap by combining secure identity replication with advanced location intelligence, providing a more reliable, scalable, and efficient solution for vehicle breakdown assistance.

III. PROBLEM STATEMENT

Roadside vehicle breakdowns present a major challenge in today's transportation systems. They cause inconvenience, safety risks, and delays for vehicle owners. Often, drivers find themselves stranded in unfamiliar or unsafe places without quick access to help. Current roadside assistance mainly relies on manual communication methods, like phone calls or third-party service providers. These methods are usually slow, inefficient, and poorly coordinated. They do not provide real-time updates on the user's location or technician availability, resulting in delays in finding and dispatching the closest service provider.

Additionally, traditional systems do not have smart decision-making abilities to allocate resources effectively based on distance, urgency, and technician availability. The lack of automated issue identification makes things harder since service providers may not know the vehicle's problem beforehand, leading to longer repair times and inefficiencies. The absence of secure verification methods can cause false or duplicate service requests, affecting system reliability and wasting precious resources.

The absence of real-time tracking and communication between users and technicians reduces transparency and raises user anxiety during emergencies. In urban areas with heavy traffic or in remote locations with poor connectivity, these problems become worse. Therefore, an intelligent, automated, and location-aware breakdown assistance system is required, incorporating real-time location tracking, issue identification, secure authentication, and automatic technician dispatch.

IV. OBJECTIVE

The primary objective of the Smart Breakdown Assistance System is to design and develop an intelligent, automated, and reliable solution that can efficiently handle vehicle breakdown situations and provide immediate support to users.

The system aims to minimize the delays and inefficiencies associated with traditional roadside

assistance methods by integrating modern technologies such as real-time location tracking, location intelligence, and automated service dispatch. By using GPS and map-based services, the system accurately identifies the user's current location and ensures that assistance is provided without unnecessary delay.

Another key objective is to implement an effective issue identification mechanism that helps in determining the type of vehicle problem during a breakdown. This enables the system to assign the most suitable technician with the required skills, thereby reducing repair time and improving service quality.

The project also focuses on optimizing resource utilization by automatically identifying and dispatching the nearest available service center or technician based on proximity, availability, and response time. In addition, the system aims to enhance user safety and overall experience by providing real-time tracking of service status and technician movement. Secure user authentication using OTP verification is incorporated to prevent false or unauthorized requests, ensuring system reliability and trust.

The project also includes the development of role-based dashboards for administrators, technicians, and customers to facilitate efficient monitoring, communication, and management of services. The system is designed to be scalable and flexible, capable of adapting to different environments and handling large numbers of users simultaneously.

V. SYSTEM ANALYSIS

System analysis is a crucial phase in the development of the Smart Breakdown Assistance System, as it focuses on identifying the limitations of existing systems and defining the requirements of the proposed solution. The proposed system analyzes the needs of three main user groups: customers, technicians, and administrators. Customers require a quick and easy way to request assistance along with real-time tracking of their service status. Technicians need an efficient platform to receive requests, locate customers, and update their availability.

Administrators require a centralized system to monitor operations, manage users, and analyze performance.

A. Existing System

The existing roadside breakdown assistance systems primarily rely on traditional and manual methods for providing support to vehicle users. When a vehicle breakdown occurs, the user contacts a service provider through phone calls or third-party service centers. This process is time-consuming and lacks efficiency, especially in emergency situations where immediate assistance is required. The communication between the user and service provider is often unstructured, leading to delays in understanding the exact problem and location of the vehicle.

Moreover, existing systems do not provide real-time tracking of the user's location or the technician's movement. This makes it difficult to identify the nearest available service provider, resulting in increased response time. The allocation of technicians is usually done manually, which may not ensure optimal resource utilization. Additionally, there is no proper mechanism for issue identification, which can lead to assigning technicians without the required expertise.

B. System Architecture

The Smart Breakdown Assistance System follows a client-server model, where the frontend is developed using React.js to provide an interactive user interface for customers, technicians, and administrators. The database is designed using MongoDB to store user details, service requests, technician data, and location information.

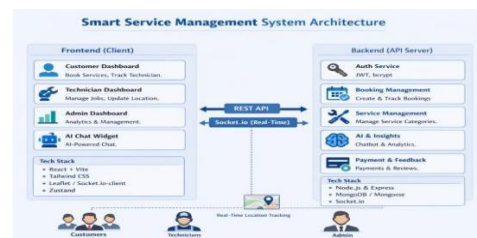


Fig. 1. System Architecture Diagram

The system architecture integrates a modern frontend developed using React, Vite, and Tailwind CSS, providing interactive dashboards for all user roles. The backend is built using Node.js and Express, handling all business logic and data processing.

Authentication is implemented using JWT and bcrypt for secure login. Communication between the frontend and backend is achieved through REST APIs for standard operations and Socket.io for real-time updates, enabling live technician tracking and instant notifications.

C. Data Flow

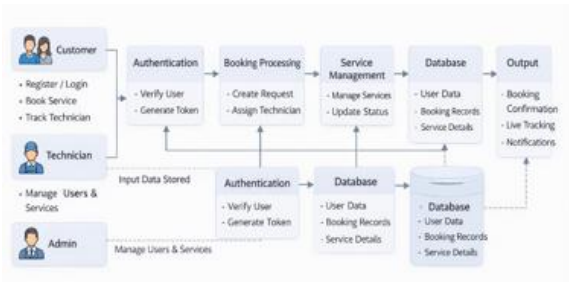


Fig. 2. Data Flow Diagram

The Data Flow Diagram (DFD) illustrates how data flows between users, system processes, and the database. The system involves three main external entities: Customer, Technician, and Admin. Customers interact with the system by registering, logging in, booking services, and tracking technicians. The booking processing module handles service requests and assigns technicians accordingly. Technicians receive job details, update their service status, and share real-time location data. All processed data is stored in the MongoDB database for future reference and analysis.

D. System Database Design

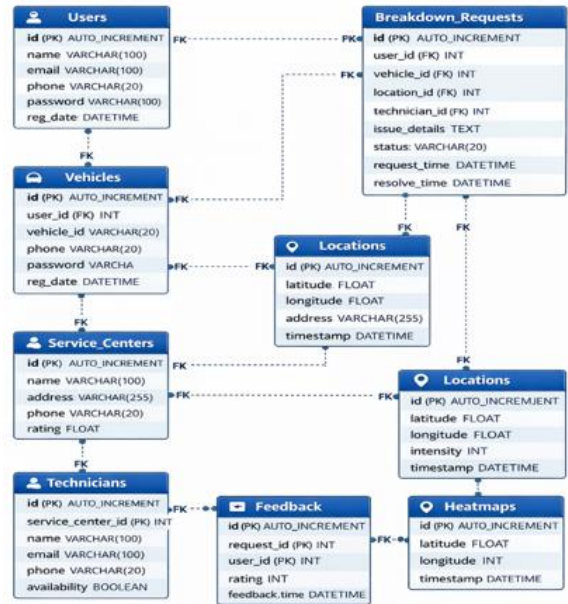


Fig. 3. System Database Diagram

The database design of the Smart Breakdown Assistance System is structured to efficiently manage all essential data related to users, vehicles, service requests, technicians, and locations. It follows a relational model where each entity is connected through primary and foreign keys to maintain data integrity and consistency. The system includes key tables such as Users, Vehicles, Breakdown Requests, Locations, Service Centers, Technicians, Feedback, and Heatmaps. The Users table stores customer details, while the Vehicles table links each vehicle to its respective user. The Breakdown Requests table acts as the core component, capturing all service requests along with technician assignment, location, issue details, and status updates. The Locations table enables real-time tracking using geographical coordinates, and the Technicians and Service Centers tables help manage service operations efficiently. Additionally, the Feedback table collects user ratings to improve service quality, and the Heatmaps table supports data analysis for identifying high-risk breakdown areas. Overall, the database is designed to ensure scalability, fast data retrieval, and smooth system performance, enabling effective service delivery and real-time assistance.

VI. METHODOLOGY

The proposed Smart Breakdown Assistance System follows a structured and modular methodology to efficiently manage service requests, technician allocation, and real-time tracking. The system is divided into multiple functional modules, each responsible for a specific stage in the service management process.

A. User Input Module

The User Input Module acts as the primary entry point of the system, allowing customers, technicians, and administrators to interact through a web-based interface. Users can input data such as registration details, login credentials, service requests, and status updates. This module ensures smooth interaction and supports dynamic data entry.

B. Authentication Module

The Authentication Module is responsible for verifying user identity and ensuring secure access to the system. It uses technologies such as JWT and bcrypt to validate login credentials and protect sensitive data. This module ensures that only authorized users can access specific functionalities based on their roles — customer, technician, or admin.

C. Booking Processing Module

The Booking Processing Module handles service requests submitted by customers. It processes user inputs, creates service bookings, and assigns technicians based on availability and location. This module ensures efficient handling of requests and smooth coordination between customers and technicians.

D. Real-Time Tracking Module

The Real-Time Tracking Module enables live tracking of technicians using Socket.io. Technicians continuously send location updates, which are processed and displayed to customers in real time. This module enhances transparency and improves user experience by providing accurate tracking information.

E. AI Assistant Module

The AI Assistant Module provides intelligent support to users through a chat-based interface. It allows users to ask queries, get service-related information, and receive automated responses. This module enhances usability and improves interaction by integrating AI-driven assistance into the system.

F. Database Management Module

The Database Management Module stores and manages all system data, including user details, booking records, service information, and tracking data. MongoDB is used to ensure efficient data storage, retrieval, and scalability. This module plays a crucial role in maintaining data consistency and reliability.

VII. RESULTS AND DISCUSSION

The Smart Breakdown Assistance System was implemented and tested to evaluate its performance in terms of real-time tracking, service request handling, and automated technician dispatch. The system demonstrated successful functionality across all major modules, achieving significant improvements in response time and service efficiency compared to traditional methods.

A. Customer Dashboard

The Customer Dashboard allows users to select breakdown issues, detect their current location via GPS, and submit a service request. The system automatically identifies the nearest available technician and dispatches assistance. The dashboard displays real-time updates on request status, technician location, and estimated arrival time.

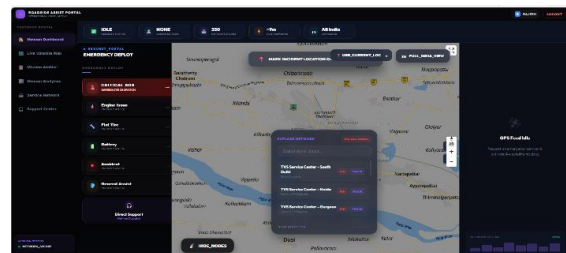


Fig. 4. Customer Dashboard — Service Request and Tracking

B. Admin Dashboard

The Admin Dashboard provides a complete overview of system performance and operations. It displays key metrics such as total requests, active technicians, network nodes, average response time, and success rate. A live map is integrated to track technician locations across different regions, along with a breakdown heatmap showing critical, active, and resolved cases. Real-time tracking improves transparency, while automation enhances overall service efficiency.



Fig. 5. Admin Dashboard — System Metrics and Live Tracking

The system results confirm that integrating real-time location tracking, automated dispatch, and role-based dashboards significantly improves the efficiency of breakdown assistance. The system provides a reliable, secure, and efficient solution for modern vehicle breakdown management.

C. Active Deployment

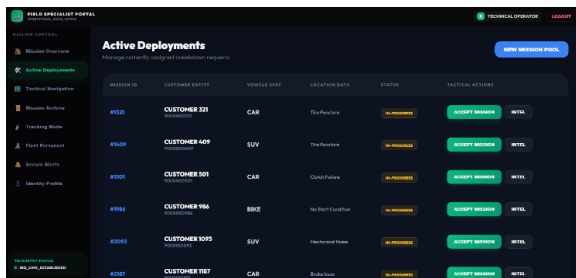


Fig. 6. Active Deployment & Mission completed Monitor

It provides a centralized interface where technicians can view all ongoing missions in a structured table format. Each entry includes details such as mission ID, customer information, vehicle type, issue description, and current status. The dashboard allows technicians to take immediate action through options like “Accept Mission” and “Intel,” enabling them to start or analyze a service request quickly. The sidebar navigation offers access to various modules such as

mission overview, tracking mode, navigation, and alerts, making it easy to manage different tasks within the system. The presence of status indicators like “In-Progress” helps technicians prioritize their work, while the telemetry status ensures that system connectivity and tracking features are active. Overall, this portal enhances operational efficiency by providing real-time updates, quick access to information, and seamless interaction for field technicians in the Smart Breakdown Assistance System.

VIII. CONCLUSION

The Smart Breakdown Assistance System successfully provides an intelligent and automated solution for managing vehicle breakdown situations. By integrating real-time location tracking, issue identification, and automatic technician dispatch, the system overcomes the limitations of traditional roadside assistance methods. It ensures faster response times, efficient resource utilization, and improved coordination between users and service providers. The system's modular architecture demonstrates a viable and scalable approach to modernizing vehicle breakdown management.

IX. LIMITATIONS

While the Smart Breakdown Assistance System demonstrates strong performance, several limitations must be acknowledged. The system's effectiveness depends on stable GPS signal availability; in areas with poor satellite connectivity or dense urban environments, location accuracy may be reduced.

The system requires a reliable internet connection for real-time tracking and communication. In remote or low-connectivity areas, the real-time features may be hindered. The OTP-based authentication also relies on mobile network availability, which may not always be guaranteed during emergency situations. Additionally, the current implementation depends on user-reported issue information, which may be inaccurate, as automated vehicle sensor integration is not yet included.

X. FUTURE ENHANCEMENT

The Smart Breakdown Assistance System can be further improved by integrating Artificial Intelligence and Machine Learning to predict vehicle failures in advance based on usage patterns and historical data, enabling preventive maintenance alerts to users.

The system can be extended by integrating IoT sensors in vehicles to automatically detect breakdown issues without user input, enabling faster and more accurate problem identification. Implementing voice assistance and chatbot support can make the system more user-friendly during emergency situations.

Integration of real-time traffic data to optimize technician routing and reduce response time is another planned enhancement. The system can also include online payment and digital billing features for seamless transactions. Expanding support for multi-language interfaces and wider geographic coverage will further increase accessibility for diverse user groups.

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