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Mechgo-Smart Mechanic Finder for Vehicle Breakdown Assistance

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Abstract- Unexpected vehicle breakdowns can leave drivers waiting beside a road while they search for a suitable mechanic, explain the fault, compare prices, and arrange help. These steps may be difficult when the driver is unfamiliar with the area or cannot judge which service provider is available. This paper proposes a Vehicle Breakdown Assistance System, a web and mobile application intended to connect vehicle owners with nearby mechanics through a structured, location-aware workflow. Customers can register, select a vehicle type and breakdown issue, share their GPS location, review service estimates, and approve a mechanic before a booking is confirmed. The system ranks eligible mechanics using distance, online availability, service capability, and request status. To reduce delays when a mechanic is unavailable, requests are sent in batches of three eligible mechanics; if all offers are rejected or expire, the server tries the next batch. The proposed technology stack uses Flutter and Dart for mobile applications, react for the administration portal, Node.js and Express.js for backend services, PostgreSQL for structured records, Google Maps Platform for routes and estimated travel time, Firebase Cloud Messaging for push notifications, and Socket.IO for live status updates where a persistent connection is suitable. The design also covers live location sharing, final billing, service history, ratings, and workshop or towing transfer when roadside repair is not possible. The paper describes the architecture, workflow, matching algorithm, expected behavior, limitations, and future extensions. Since the project is presented as a proposed design, no measured accuracy, response-time, or user-satisfaction results are claimed. The next step is implementation followed by controlled functional, usability, security, and field testing.

Keywords- roadside assistance, vehicle breakdown, GPS, mechanic matching, real-time tracking, mobile application, web application, service allocation.

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

I. Introduction

1. Background and Problem Statement

A vehicle breakdown can occur because of a punctured tyre, a weak or failed battery, an engine fault, fuel-related trouble, or a starting problem. When a failure happens away from home, the driver may not know a nearby workshop or which mechanic can handle the issue. A driver may have to call several garages, describe the location repeatedly, ask about the likely cost, and wait for a response. Informal phone-based arrangements can make it difficult to compare offers or know whether help is actually on the way.

Mobile mapping and networked applications provide a practical basis for improving this process. A location-aware service can capture the breakdown point, identify nearby providers, estimate travel distance, and deliver request updates to both sides. Prior work on mobile vehicle assistance has explored assistance and maintenance features in a mobile application [1]. More recent web-based project work has also described on-demand mechanic discovery and geolocation-based matching [2]. These examples indicate that location-aware assistance is a relevant application area, while leaving room for clearer request-allocation rules, price approval, and reliable handling of rejected or unanswered offers.

2. Motivation

The main motivation is to replace repeated manual searching with one transparent workflow. A customer should be able to report a problem, see the proposed service charge and estimated arrival time, and make an informed choice before confirming a booking. Mechanics need a clear request containing the location, vehicle category, issue type, and customer contact details needed to provide assistance. Administrators need a controlled view of users, service providers, bookings, complaints, and service records.

3. Objectives

Provide customer and mechanic registration with authenticated access.

- Capture a customer’s current location, subject to permission, and allow manual location correction.

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

- Match requests to eligible nearby mechanics based on availability, distance, capability, and current workload.
- Send offers to up to three mechanics at a time and retry with the next group after rejection or timeout.
- Show estimated charges, distance, and arrival time before the customer confirms the booking.
- Support live status and location updates, notifications, final billing, ratings, and service history.
- Provide an admin portal for reviewing accounts, mechanics, bookings, and service records.

4. Scope

The proposed system focuses on coordinating roadside repair for bikes, cars, and lorries. Example issue categories include puncture, battery failure, engine problems, and starting problems. It supports cases where a mechanic can repair the vehicle at the breakdown location and cases where the vehicle must be moved to a workshop. The system does not automatically diagnose every mechanical fault, guarantee a repair, or replace emergency services when a location is unsafe.

II. Literature Review

1. Research on Mobile Vehicle Assistance

Wickrama et al. presented “Mobile Based Solution for Vehicle Assistance” at the 2021 International Conference on Advancements in Computing [1]. The publication describes a mobile application intended to support drivers facing breakdowns and maintenance needs, with additional functions related to maintenance prediction, spare-part pricing, and insurance information. Its stated approach combines several software techniques, including natural-language processing, neural networks, and sentiment analysis. This work is directly related to the present project because both aim to help vehicle owners access assistance through a mobile interface. The proposed system in this paper has a narrower operational focus: it emphasizes dispatching available mechanics in controlled batches, showing service estimates, obtaining customer approval, and managing the booking lifecycle.

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

Varia et al. describe “Ride Rescue—On Demand Motor Mechanic Service,” a web-oriented platform for requesting motor-mechanic support using geolocation and real-time updates [2]. The paper’s stated goal is to make it easier to request a mechanic without relying on repeated calls. This is closely aligned with location-aware matching. However, a college project should distinguish a described implementation from independently reproduced results. The present paper therefore uses this publication as related project work and does not transfer its performance observations or claim that the proposed design has the same implementation or measured outcomes.

2. Mapping, Routing, and Location Services

Google Maps Platform provides mapping and routing services. Its Routes API can calculate routes and route matrices, including distance and travel-time information for specified origins and destinations [3]. These capabilities can support the display of a mechanic’s estimated travel distance and arrival time. The estimate must be treated as an estimate rather than a promise: road conditions, traffic, location quality, route restrictions, and delays after acceptance can change the actual arrival time. Device location is also permission-dependent, and the interface should allow a customer to correct a GPS point when it is not accurate enough.

3. Notifications and Real-Time Communication

Firebase Cloud Messaging (FCM) is a cross-platform messaging service that can deliver notification or data messages to mobile and web clients [4]. It can notify a mechanic of a new offer and inform a customer about acceptance, arrival, or completion. Socket.IO supports low-latency, bidirectional, event-based communication between a client and server [5]. It is suitable for updates while the application is connected, such as booking status and location changes. Push notifications and live sockets serve different purposes: a push notification can alert a user when the app is in the background, while Socket.IO can update an active screen. Important state changes must still be saved on the server and database, because network delivery alone should not be treated as proof that an event was processed.

4. Existing Roadside Assistance Services and Research Gap

Established roadside assistance providers show that roadside support can be organized as a service offering, but their service coverage, eligibility rules, prices, and

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

availability vary by country and provider. For example, AAA publishes information about its roadside assistance service [6]. Such service websites are useful for understanding the customer-facing service model, but they are not independent academic evaluations of the system proposed here.

The reviewed sources support the general feasibility of mobile assistance, mapping, notifications, and real-time communication. The design gap addressed in this paper is the combination of several explicit workflow controls in one student-project architecture: (i) offers sent to no more than three eligible mechanics in each batch, (ii) automatic retry after rejection or timeout, (iii) customer approval of the estimated charge before confirmation, and (iv) server-side protection against duplicate acceptance. These are design objectives, not claims that no existing commercial platform has such features. A systematic comparison of commercial systems would require current product documentation and hands-on testing.

Related source	Main focus	Relevance to this project	Boundary / limitation
Wickrama et al. [1]	Mobile vehicle assistance and maintenance support	Shows a related mobile assistance concept	Different feature scope; results are not transferred to this design
Varia et al. [2]	On-demand mechanic service with geolocation	Closely related to mechanic discovery and requests	Published project paper; not treated as independent validation
Google Maps Routes API [3]	Routes, distance, and travel-time calculation	Supports distance and ETA display	Depends on service coverage, location quality, and changing road conditions
FCM and Socket.IO [4], [5]	Push messages and real-time events	Supports request alerts and live status	Network failures and client disconnection still require recovery logic
AAA roadside assistance [6]	Customer-facing roadside assistance service	Provides an example of an existing service model	Service availability and terms vary by location

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

III. Proposed System Architecture

The system follows a client–server architecture. Mobile applications provide the customer and mechanic interfaces. A React-based web portal provides administrative functions. The Node.js and Express.js backend validates requests, applies matching rules, manages booking state, and communicates with the database and external services. PostgreSQL stores structured records. Google Maps Platform supports map display and route calculations. FCM sends push notifications, while Socket.IO may be used for immediate status and location events.

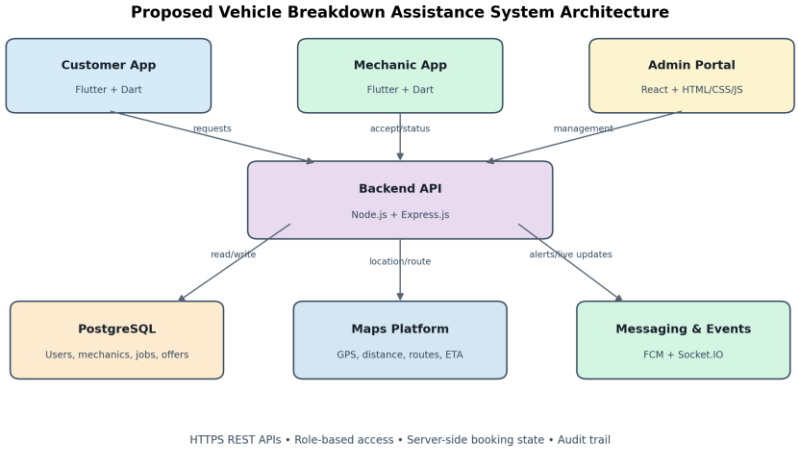


Fig. 1. Proposed high-level architecture of the Vehicle Breakdown Assistance System.

1. Customer Application

The customer application supports registration, login, vehicle profile selection, breakdown reporting, GPS location sharing, review of mechanic offers, charge approval, booking status, live tracking, payment or bill review where enabled, and

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

feedback. The customer can select bike, car, or lorry and choose a problem category such as puncture, battery failure, engine problem, or starting problem. A short text description and optional photo may help the mechanic prepare, but photos should not be mandatory for creating a request.

2. Mechanic Application

Mechanics register with contact details, service area, supported vehicle types, repair skills, and any verification information required by the service operator. A mechanic can switch between online and offline states. Online status alone does not guarantee eligibility: the backend should also check whether the mechanic is verified, supports the requested vehicle and issue, has no conflicting active job, and has not already responded to the same request. A mechanic receives an offer, reviews the job details, and accepts or rejects it within the response window.

3. Admin Web Portal

The admin portal allows authorized staff to view customer and mechanic accounts, verify or suspend mechanic profiles, monitor booking status, inspect service records, handle complaints, and review ratings. Administrative actions should be role-restricted and recorded in an audit log. The portal should not expose more customer location history than is required for service management.

4. Backend, Database, and External Services

The backend exposes authenticated REST endpoints and validates every important state change. PostgreSQL stores users, vehicles, mechanic skills, availability, requests, offers, bookings, location updates, invoices, and feedback. The database should use primary keys, foreign keys, indexes, and transactions where needed to maintain consistent records [7]. Node.js and Express.js are proposed for API services; Flutter provides a shared codebase approach for mobile clients [8], while React supports reusable interface components for the web portal [9].

Google Maps Platform can calculate routes and travel-time estimates [3]. FCM can deliver background alerts [4]. Socket.IO can deliver live updates to connected clients [5]. API keys and service credentials must be kept out of public source code, and access to location data should be restricted by role and purpose.

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

Component	Proposed technology	Main responsibility
Customer and mechanic apps	Flutter + Dart	Mobile screens, location permission, offer response, booking status
Admin web portal	React.js, HTML, CSS, JavaScript	Account review, booking monitoring, reports, complaint handling
Backend	Node.js + Express.js	Authentication, request validation, matching, state transitions, APIs
Database	PostgreSQL	Persistent structured records and transactional updates
Maps and routing	Google Maps Platform	Map display, routes, distance and estimated travel time
Push notification	Firebase Cloud Messaging	New-offer alerts and booking notifications
Real-time events	Socket.IO (optional)	Live booking status and mechanic location updates

IV. System Methodology

1. Registration and Authentication

A customer or mechanic creates an account using the required contact details and credentials. The backend validates the input, stores a password hash rather than a plain-text password, and assigns a role. Mechanic accounts may remain pending until an administrator completes the verification process. Authentication tokens should expire according to a defined policy, and sensitive endpoints must check both identity and role.

2. Breakdown Reporting and Location Detection

The customer starts a request by selecting the vehicle type and breakdown category. The application asks for location permission and obtains latitude and longitude when permission is granted. The user sees the selected point on a map and can correct it manually, for example by moving a pin to the road shoulder or a nearby landmark. The request record stores the coordinates, timestamp, selected issue, optional notes, and a

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

status such as REQUESTED. If GPS is unavailable, the system should allow a manually entered location or clearly explain that automatic matching may be less accurate.

3. Eligible Mechanic Search and Ranking

The backend filters mechanics using online status, account verification, supported vehicle type, supported repair category, service radius, and absence of a conflicting assignment. The remaining candidates are ordered by estimated route time or distance, with optional tie-breakers such as rating or recent workload. Rating should not override basic eligibility or safety checks. A route estimate may be requested from Google Maps Platform; a simpler coordinate-distance calculation can be used for initial filtering, followed by route calculations for the shortlist.

For two geographic points with latitude and longitude in radians, the Haversine formula gives an approximate great-circle distance:

$$a = \sin^2(\Delta\varphi/2) + \cos(\varphi_1)\cos(\varphi_2)\sin^2(\Delta\lambda/2)$$
$$d = 2R \cdot \operatorname{atan2}(\sqrt{a}, \sqrt{(1-a)})$$

Here, φ is latitude, λ is longitude, Δ indicates the difference between two coordinates, and R is the mean Earth radius (approximately 6,371 km). This distance is a filtering estimate, not road distance. The displayed travel distance and estimated arrival time should use route data where available.

4. Three-Mechanic Offer Batches

The system sends an offer to at most three eligible mechanics in the first batch. Each offer has a unique identifier, request identifier, mechanic identifier, creation time, expiry time, and response state. The customer is not yet given a confirmed booking at this stage. The mechanic may accept or reject the offer, or the offer may expire if there is no response. If one or more mechanics accept at nearly the same time, the server uses an atomic database transaction or equivalent locking rule to grant the job to only one mechanic. Other offers are closed as no longer available.

5. Estimate and Customer Approval

The mechanic or system presents an estimated service charge, expected travel distance, and estimated arrival time. The estimate should identify whether it includes

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

call-out charges, labour, parts, taxes, or other fees. The customer must approve the estimate before the booking is confirmed. If the customer declines, the request can be cancelled or returned to the matching stage according to a clear policy. Any later change to the estimate requires customer approval before extra work is performed, except where a separately agreed emergency policy applies.

6. Tracking, Repair, and Workshop Transfer

After confirmation, the mechanic app periodically sends location updates while travelling, subject to customer consent and battery/network constraints. The customer sees the mechanic's last reported position, status, and updated arrival estimate. Suggested statuses are CONFIRMED, EN_ROUTE, ARRIVED, DIAGNOSING, REPAIRING, COMPLETED, and CANCELLED. If roadside repair is not possible, the mechanic records the reason and proposes transfer to a suitable workshop or towing provider. The customer approves the transfer and any additional charge before it is arranged.

7. Billing, History, and Feedback

At completion, the system creates a final bill containing the approved estimate, additional approved work, parts, labour, taxes where applicable, and total amount. The customer can review the bill and submit a rating and written feedback. Completed jobs are added to service history for the customer and mechanic. The admin portal can use these records to investigate complaints and monitor service quality. If online payment is not part of the first version, the bill can record an agreed offline payment method without implying that payment processing is implemented.

V. Mechanic Matching and Request Allocation Algorithm

1. Design Rules

- Only verified, online, qualified mechanics without a conflicting active assignment are eligible.
- Each dispatch batch contains up to three mechanics; fewer may be sent if fewer eligible mechanics exist.
- Each offer has a unique ID and a server-controlled expiry time.

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

- A request can have only one confirmed mechanic assignment.
- A response is valid only if the offer is still open and the mechanic remains eligible.
- After all offers in a batch are rejected or expire, the next batch is created from remaining eligible mechanics.
- The retry process stops when a mechanic is confirmed, the customer cancels, or no eligible mechanics remain.

2. Pseudocode

```
INPUT: breakdown request r
eligible ← find verified, online mechanics matching vehicle, issue, service area, and workload
eligible ← sort eligible by route ETA (then distance as tie-breaker)
while r is active AND eligible is not empty:
  batch ← first min(3, number of eligible) mechanics
  remove batch mechanics from eligible
  create one unique offer per mechanic with a common expiry window
  notify all mechanics in batch
  wait until an offer is accepted, all offers are rejected, or all offers expire
  if one or more valid acceptances exist:
    begin atomic transaction
    if r has no confirmed mechanic AND accepted offer is still open:
      assign exactly one accepted mechanic to r
      close all other open offers for r
      commit transaction; notify customer and mechanics
      collect/show estimate and obtain customer approval
      if customer approves: confirm booking and start tracking
      else: cancel or restart matching according to policy
      stop
    else: rollback and close stale acceptance
  else:
    mark batch offers rejected/expired and continue
if r is still active AND no mechanic was assigned:
```

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

notify customer that no eligible mechanic accepted; offer retry/cancel

3. Timeout and Duplicate-Assignment Prevention

The timeout is a configurable server-side value. A client countdown is only a display aid; the server clock determines whether an offer is still valid. Every response should be checked against the request ID, offer ID, mechanic ID, offer state, and expiry time. The database should enforce a single confirmed assignment per request, for example through a transaction and a uniqueness rule on the active assignment. Repeated network messages should be handled idempotently: processing the same acceptance twice must not create two bookings. When a customer cancels or approves an estimate, the server should verify that the request is still in the expected state before applying the change.

4. State Model

State	Meaning	Typical next state
REQUESTED	Customer submitted a breakdown report	MATCHING / CANCELLED
MATCHING	Offers are being sent in batches	OFFER_PENDING / NO_PROVIDER
OFFER_PENDING	One batch has open offers	MATCHING / ESTIMATE_PENDING
ESTIMATE_PENDING	A mechanic is selected and estimate is awaiting approval	CONFIRMED / CANCELLED
CONFIRMED	Customer approved the estimate and booking	EN_ROUTE
EN_ROUTE / ARRIVED	Mechanic is travelling or has reached the location	DIAGNOSING
REPAIRING	Repair is in progress	COMPLETED / WORKSHOP_TRANSFER
WORKSHOP_TRANSFER	Roadside repair is not suitable and transfer is arranged	COMPLETED
COMPLETED	Final bill and service record are saved	CLOSED

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Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

VI. Expected Results and Discussion

The system is at the proposed-design stage in this paper. The results below describe expected behavior and acceptance criteria for future testing; they are not measured results from a completed implementation.

1. Expected Scenario Behavior

Scenario	Expected system response	Evidence to collect during testing
Puncture on a roadside	Capture location, select bike/car, find eligible mechanics, send up to three offers, display estimate and ETA	Request record, offer logs, route response, customer approval record
All first-batch mechanics reject	Close the first batch and send offers to the next eligible group	Timestamped offer states and proof that the second batch follows the first
No response before timeout	Expire open offers and automatically retry, unless cancelled or no candidates remain	Timeout logs and batch sequence
Two mechanics accept almost together	Assign only one mechanic; close the other offer as already assigned	Database state and duplicate-assignment test
GPS point is inaccurate	Allow customer to correct the pin or enter a location manually	Permission flow and corrected coordinates
Roadside repair is not possible	Record reason and propose workshop/towing transfer with customer approval	Transfer status, approval, and updated cost record
Mobile data briefly disconnects	Persist booking state on server and resynchronize when connection returns	Reconnect test and consistent status history

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

2. Discussion

The proposed batch approach is intended to reduce the number of mechanics who receive the same request at one time while still allowing parallel responses. The batch size of three is a project rule, not a value proven to be optimal. A future evaluation should compare several batch sizes using simulated or field data and measure time to acceptance, percentage of requests receiving a response, cancellation rate, and mechanic workload. Any such comparison should use a stated sample, test environment, and calculation method.

The customer approval step is intended to improve price transparency, but the quality of the estimate depends on the information available before inspection. Some faults cannot be priced accurately until the mechanic examines the vehicle. The interface should therefore label the value as an estimate and require approval if the amount changes. Likewise, ETA depends on route estimates and changing conditions. The system should avoid presenting an estimated arrival time as a guarantee.

3. Proposed Evaluation Plan

The first evaluation phase should use scripted tests with simulated mechanic profiles and known request states. The second phase should use a small controlled pilot with consenting users and verified mechanics. Measures may include successful registration rate, location-capture success, median time to first response, time to confirmed assignment, correct retry behavior, duplicate-assignment incidents, notification delivery observations, status synchronization, and user-reported usability. Results should be reported only after the tests are performed, with test dates, sample sizes, and limitations.

Advantages and Limitations

Advantages

- Reduces the need for customers to search for mechanics through repeated phone calls.
- Uses location and availability to prioritize mechanics who may be able to reach the breakdown point.

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

- Shows distance, estimated arrival time, and service charges before the customer confirms the booking.
- Uses three-mechanic batches and automatic retries to manage rejections and unanswered offers.
- Maintains booking status, final bills, service history, ratings, and feedback in one system.
- Supports both roadside repair and a controlled transfer to a workshop when necessary.
- Provides administrators with a central view of mechanics, customers, bookings, and service records.

Limitations

- The system requires a working internet connection for online matching, status updates, and most map features.
- GPS may be inaccurate near tall buildings, tunnels, dense urban areas, or roads with limited signal; users need a manual correction option.
- An online mechanic may still be busy, unreachable, or unable to repair the reported fault.
- Estimated costs may change after inspection; customer approval is needed for revised charges.
- Map services, messaging, hosting, and mobile data can introduce operating costs and service dependencies.
- Location and contact details are sensitive; access control, encryption, limited retention, and clear consent are necessary.
- The design has not yet been validated through field deployment, so reliability, usability, and performance remain to be measured.
- A single platform cannot guarantee that a safe roadside repair is possible; emergency situations may require local emergency services instead.

Applications

Individual vehicle owners can use the system when a vehicle stops working away from home or a familiar garage. Roadside assistance providers can use it to dispatch their enrolled mechanics and monitor open requests. Independent garages can receive

International Journal for Research Trends in Social Science & Humanities
ISSN: 2584-2455
Volume 4, Issue 5
Sep-Oct- 2026, PP 1-18

nearby jobs when their staff and equipment are suitable. Towing providers can be included when a vehicle cannot be repaired at the breakdown point. Fleet operators can use the admin portal to coordinate assistance for delivery vehicles, service vans, or company cars and to review maintenance-related service records. These applications depend on local provider participation, operational rules, and service coverage.

Future Scope

- Online payments and digital invoices through a secure payment provider, with payment status reconciled against the booking record.
- AI-assisted recommendations based on issue type, mechanic skills, historical service quality, route time, and customer feedback, while keeping recommendations explainable.
- Multilingual interfaces and voice-assisted breakdown reporting for users who prefer local languages.
- Expansion to more towns and regions through configurable service areas, mechanic onboarding, and local operating partnerships.
- Preventive maintenance reminders based on vehicle age, usage, and service history, where users provide reliable information.
- Support for additional vehicle categories, including commercial vehicles and electric vehicles, with appropriately trained mechanics.
- Offline-tolerant request drafting and automatic synchronization when connectivity returns.
- Safety features such as sharing a booking with a trusted contact, verified mechanic identification, and clear guidance for dangerous roadside locations.
- Analytics for providers, including peak-demand areas, response times, repeated fault categories, and service coverage gaps, using privacy-conscious aggregation.

VII. Conclusion

This paper has proposed a Vehicle Breakdown Assistance System that connects vehicle owners with nearby available mechanics through a location-aware web and mobile workflow. The design combines customer and mechanic applications, an admin portal, a backend API, a relational database, mapping services, push notifications, and

optional real-time communication. Its central workflow sends offers to up to three eligible mechanics at a time, retries with the next group after rejection or timeout, and prevents multiple mechanics from being assigned to the same request. Customers can review service charges, distance, and estimated arrival time before approving a booking, then follow service progress and review the final bill.

The proposed design also addresses cases in which roadside repair is not possible by allowing a customer-approved workshop or towing transfer. The architecture uses widely documented technologies, but technology selection alone does not establish system quality. The project must next be implemented and evaluated for functional correctness, security, usability, location quality, notification behavior, and performance under concurrent responses. Until that work is completed, the benefits described in this paper should be treated as expected outcomes rather than experimentally demonstrated results.

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