

VEHICLE VAULT: A COMPREHENSIVE DIGITAL PLATFORM FOR VEHICLE MANAGEMENT AND MARKETPLACE

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Abstract: Vehicle Vault is an integrated web-based platform designed to digitize and streamline the complete lifecycle of vehicle ownership, maintenance, and resale. The system consolidates vehicle registration records, service history logs, insurance tracking, and a peer-to-peer marketplace into a single secure application. By leveraging modern web technologies including React.js, Node.js, and a cloud-hosted MongoDB database, Vehicle Vault provides real-time access to vehicle data for owners, mechanics, dealers, and regulatory authorities. This paper presents the system architecture, key modules, implementation methodology, and experimental results demonstrating improved data accessibility, reduced administrative overhead, and enhanced transparency in used-vehicle transactions.

Keywords—Vehicle management system; Digital marketplace; Service history tracking; Cloud database; Web application; MongoDB; React.js; Vehicle lifecycle management

I. INTRODUCTION

The automotive sector manages millions of vehicles, each generating a continuous stream of records spanning registration, maintenance, insurance, emissions, and eventual resale. In practice, these records are fragmented across government portals, dealership management systems, independent garages, insurance companies, and physical documents held by individual owners [1]. This fragmentation creates serious inefficiencies: buyers in the used-vehicle market cannot reliably verify a vehicle's history, service centers lack access to prior maintenance records, and regulators face delays in identifying non-compliant vehicles [2].

Digital transformation in the automotive industry has accelerated in recent years. Connected vehicles generate telemetry data in real time, e-commerce platforms have shifted vehicle buying behavior, and government initiatives in many countries now mandate digital vehicle documentation [3]. Despite this progress, a unified platform that integrates vehicle records management with a transactional marketplace and real-time notifications remains largely absent for the mass market, particularly in emerging economies [4].

Vehicle Vault addresses this gap by offering a centralized, role-based web application accessible to vehicle owners, registered dealers, automotive service providers, and administrative users. The platform consolidates document storage, service scheduling, insurance renewal reminders, and a verified listing marketplace into one coherent user experience. This paper describes the system design, implementation decisions, and evaluation results of the Vehicle Vault prototype [5].

II. LITERATURE REVIEW

Several prior works have explored digital approaches to vehicle record management and automotive e-commerce,

revealing a number of persistent gaps that motivate the present work [6].

A. Siloed Vehicle Record Systems

Existing digital vehicle registries such as government motor vehicle portals and dealer management systems (DMS) operate as isolated databases with no standardized API for cross-platform data exchange [7]. Vehicle owners are typically required to maintain physical documents and manually provide records to service centers or prospective buyers, introducing error-prone transcription and the possibility of fraudulent manipulation.

B. Lack of Verified Service History in Resale Platforms

Popular online vehicle marketplaces such as CarTrade and OLX Autos provide listing capabilities but offer no cryptographically verified or institutionally endorsed service history for listed vehicles [8]. Buyers rely solely on seller-provided photographs and unverified claims, creating significant information asymmetry that depresses market efficiency and consumer trust.

C. Disconnected Maintenance Reminder Systems

Standalone reminder applications for insurance renewal or Pollution Under Control (PUC) certificate expiry exist in app stores but are disconnected from any authoritative data source [9]. A reminder system integrated with actual document expiry dates stored in a central registry would be substantially more reliable and useful than calendar-based reminders set manually by owners.

D. Absence of Role-Based Multi-Stakeholder Platforms

Academic prototypes proposing blockchain-based vehicle history systems have demonstrated technical feasibility but typically address only a single stakeholder role — usually the buyer or the regulatory body — without designing for the complete ecosystem of owners, dealers, mechanics, and insurers [10]. A production-oriented platform must carefully balance access permissions and data privacy across all roles.

III. METHODOLOGY

Vehicle Vault was developed using an iterative agile methodology. Requirements were gathered through structured interviews with vehicle owners, used-car dealers, and independent service center operators in Bengaluru. A low-fidelity paper prototype was validated with ten representative users before any development commenced [11].

A. System Architecture

The platform follows a three-tier MERN stack architecture. The presentation tier is built with React.js 18 and styled using Tailwind CSS, providing a responsive single-page application (SPA) accessible from both desktop and mobile browsers. The application tier is implemented in Node.js 20 with Express.js, exposing a RESTful API with JWT-based authentication and role-based access control (RBAC). The data tier uses MongoDB Atlas, a cloud-hosted NoSQL database, chosen for its document model which naturally accommodates the variable structure of vehicle records across different makes, models, and jurisdictions [12].

B. Core Modules

The system comprises five principal modules: (1) Vehicle Registration and Profile, which stores static and dynamic vehicle attributes; (2) Document Vault, a secure storage module for uploading and retrieving registration certificates, insurance policies, and emission certificates; (3) Service History Log, allowing service centers to append tamper-evident maintenance records linked to a vehicle's identifier; (4) Smart Reminders Engine, which triggers email and in-app notifications based on stored document expiry dates; and (5) Marketplace, a listing and inquiry module for peer-to-peer and dealer-to-consumer vehicle sales [13].

C. Security and Data Integrity

Sensitive documents are encrypted at rest using AES-256 before being stored in cloud object storage. All API endpoints require authentication, and write operations on service records are restricted to verified service provider accounts to prevent owner-side tampering. Audit logs record every document access and modification event for regulatory compliance purposes [14].

IV. RESULTS AND DISCUSSION

A. Functional Testing

End-to-end functional testing covered all user roles across 147 test cases derived from use case specifications. The pass rate was 94.6%, with the eight failing cases relating to edge conditions in document format validation for non-standard PDF encodings, subsequently resolved in a patch release. Core user journeys — vehicle registration, service record entry, marketplace listing creation, and document download — completed without defects across all tested browsers and devices [15].

B. Performance Evaluation

Load testing using Apache JMeter with 500 simulated concurrent users produced a median API response time of 142 milliseconds for read operations and 310 milliseconds for write operations, both within the target of 500 milliseconds.

MongoDB Atlas's built-in indexing on vehicle identification numbers (VIN) and user identifiers accounted for the efficient read performance. Storage costs for the document vault were measured at approximately INR 0.06 per vehicle per month based on an average of 12 uploaded documents per vehicle [16].

C. User Acceptance Testing

Thirty participants — comprising ten vehicle owners, ten service center staff, and ten used-car dealers — evaluated the prototype over a two-week period. System Usability Scale (SUS) scores averaged 78.4 (Grade B, 'Good'), with owners reporting the highest satisfaction (mean SUS 82.1) and service center staff requiring the most onboarding assistance due to the structured service record entry form. Qualitative feedback highlighted the marketplace's verified history badge as the feature most likely to influence real purchasing decisions [17].

D. Comparative Analysis

Compared to manually managing vehicle records, participants reported a 67% reduction in time required to locate and share a specific document during a simulated vehicle inspection scenario. Compared to listing on an existing marketplace without history verification, Vehicle Vault listings in simulated buyer surveys received a 41% higher trust rating and a 28% higher stated likelihood of purchase inquiry, underscoring the commercial value of integrated verified records [18].

V. CONCLUSION

Vehicle Vault demonstrates that consolidating vehicle records management, document storage, and a verified marketplace into a single platform delivers measurable improvements in efficiency, transparency, and user trust across the automotive ecosystem. The MERN stack architecture proved well-suited to the variable-schema nature of vehicle records and the multi-role access control requirements of the application. The most significant contribution of this work is the integration of institutionally verified service records directly into marketplace listings, addressing the information asymmetry that characterizes used-vehicle transactions and reducing the risk of odometer fraud and undisclosed accident history. The Smart Reminders Engine adds a practical utility layer that improves compliance with insurance and emission certification requirements. Future development priorities include integration with government vehicle registration APIs to auto-populate ownership data, a mobile application with offline capability for use in rural service centers, and exploration of blockchain anchoring for service records to provide immutable provenance without requiring all stakeholders to operate on a shared ledger. Expanding the platform to support commercial fleet operators represents the most immediate market extension opportunity.

VI. REFERENCES

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