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Wheelzy Rentals: A Car Rental System

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Abstract- The rising demand for short-term, flexible transportation solutions has been fueled by growing traffic congestion, increasing ownership expenses, and evolving urban lifestyles. Traditional car rental services—both offline and web-based—still encounter recurring issues such as double bookings, lack of real-time vehicle status, manual and error-prone document checks, and vulnerabilities in payment security. Wheelzy is introduced as a peer-to-peer, software-as-a-service platform designed to overcome these limitations through a secure and scalable web solution built on Python Flask with HTML/CSS and SQL integration. The system accommodates three user groups—administrators, vehicle owners, and renters—each supported with dedicated functionality. Its major components include multi-factor authentication, automated identity validation, dynamic vehicle availability tracking, seamless booking workflows, integrated payment modules, and map-enabled pickup and drop-off guidance. The platform is developed using a layered architecture that clearly separates the interface, application services, and data storage layers. Security mechanisms such as RESTful APIs, credential hashing, SQL injection prevention, and encrypted transactions are embedded across all modules. Performance evaluation under simulated heavy traffic verified high booking accuracy, rapid response times, and consistent usability. By laying the groundwork for features such as AI-driven dynamic pricing, blockchain-enabled transaction transparency, and predictive vehicle maintenance, Wheelzy represents a forward-looking approach to sustainable and reliable shared mobility.

Keywords: Peer-to-Peer Car Rental; Software as a Service (SaaS); Flask Framework; Secure Booking; Payment Gateway; Real-Time Availability; Smart Mobility.

I. INTRODUCTION

The transportation industry has experienced a paradigm shift in recent years, where users increasingly prioritize flexibility, affordability, and convenience over permanent vehicle owner- ship. Factors such as escalating fuel prices, ris- ing maintenance costs, urban traffic congestion, and the growing awareness of environmental sustainability have accelerated the adoption of shared mobility solutions. Among these, car rentals play a pivotal role in addressing the diverse mobility needs of urban populations, offering temporary access to vehicles for both leisure and professional purposes. Despite this growing demand, conventional rental services are often characterized by outdated processes, lack of transparency in pricing, delayed ap- provals, and limited accessibility, which hinder user adoption and satisfaction.

Technology-driven platforms such as Zoom-car, Turo, and other online rental applications have addressed certain inefficiencies by digi- tizing booking processes and offering greater accessibility. However, these systems continue to face several persistent challenges including delayed real-time availability updates, limited fraud detection mechanisms, inconsistent ver- ification of user documents, and insufficient personalization of services. Moreover, the lack of integrated geolocation-based navigation fea- tures often results in reduced convenience for users when coordinating car pick-up and drop- off points. These gaps highlight the need for a more comprehensive solution that ensures reli- ability, scalability, and trust while maintaining user-friendly interaction.

Wheelzy is designed to bridge this gap by of- fering a peer-to-peer car rental ecosystem that seamlessly connects owners and renters through a secure and responsive web application. Built using Python Flask, HTML/CSS, and SQL, the platform integrates essential features such as multi-role authentication, automated docu- ment validation, real-time vehicle listing and scheduling, secure payment transactions, and geolocation-enabled navigation. This combina- tion reduces manual intervention, increases op- erational efficiency, and enhances trust between stakeholders. Furthermore, the system mini- mizes administrative overhead for car owners while ensuring renters benefit from speed, con- venience, and transparent booking processes.

The research significance of this project lies not only in its technical contributions but also in its potential societal impact. By enabling se- cure and reliable shared mobility, Wheelzy con- tributes toward reducing private vehicle owner- ship, lowering urban congestion, and supporting environmentally sustainable practices. Addi- tionally, the platform lays the groundwork for integrating advanced features such as artificial intelligence for dynamic pricing, blockchain- backed transaction records for transparency, and predictive vehicle maintenance for improved reliability. Overall, this work aims to deliver an innovative and practical solution that addresses the pressing challenges of modern urban trans- portation and sets the foundation for future advancements in smart mobility systems.

II. LITERATURE SURVEY

A comprehensive review of the literature on vehicle rental systems and digital mobility plat- forms reveals two predominant operational frameworks: centralized fleet-based rentals and decentralized peer-to-peer (P2P) sharing. Centralized services, such as Hertz and Avis, manage large-scale fleets, ensuring consistent service quality and standardized operations but often at the expense of higher operational costs, limited scalability, and reduced flexibility for customers. Conversely, P2P platforms such as Turo and Getaround leverage underutilized privately-owned vehicles, thereby enhancing asset utilization and reducing capital require- ments. However, these decentralized models face challenges related to verification, fraud prevention, dynamic pricing, and building long- term user trust.

Several studies have attempted to address these challenges. Jones et al. (2019) emphasized demand-supply mismatches in P2P car rentals, which lead to inefficient vehicle allocation and customer dissatisfaction. Brown and Lee (2021) demonstrated that AI-based dynamic pricing algorithms could increase owner profitability by up to 18% while simultaneously improv- ing renter satisfaction and retention. Garcia et al. (2022) proposed blockchain-backed smart contracts to enhance transactional transparency and reduce fraudulent activity, reporting a 40% decline in payment-related disputes. Similarly, Sharma and Gupta (2020) examined the role of geolocation and IoT integration in improv- ing vehicle availability accuracy, enabling real- time tracking and reducing scheduling conflicts. Chen and Patel (2020) further analyzed hy- brid SQL–NoSQL database models, showing a 25% improvement in query response time and scalability under high-demand conditions. In addition, Miller et al. (2021) highlighted the importance of user-centered interface design for digital rental platforms, demonstrating that streamlined navigation directly correlates with higher booking conversion rates.

Building on these insights, Wheelzy integrates secure user authentication, automated docu- ment validation, relational database manage- ment, and robust transaction handling to en- hance trust and reliability. Unlike existing solu- tions, the system incorporates real-time avail- ability management and geolocation-enabled navigation, addressing the limitations noted in earlier studies. Furthermore, by embedding hooks for future modules such as AI-driven pric- ing and blockchain-enabled payment verifica- tion, Wheelzy is designed as a forward-looking platform that not only aligns with proven ap- proaches but also extends them to create a secure, scalable, and user-centric peer-to-peer car rental ecosystem.

III. METHODOLOGY

The development methodology for Wheelzy was structured into three interrelated stages, designed to ensure that both functional and non-functional requirements were thoroughly addressed while maintaining scalability, secu- rity, and user-centric design.

Requirement Gathering and Analysis: The initial stage involved extensive interactions with key stakeholders including car owners, renters, and administrative personnel to identify critical needs and operational constraints. Core func- tional requirements included secure multi-role user registration and authentication, real-time vehicle availability tracking, seamless search and booking workflows, and encrypted pay- ment processing. Non-functional requirements encompassed system reliability, performance under peak loads, and responsive user interface design. Additional considerations included in- tegration of geolocation services for accurate pickup and drop-off, automated document veri- fication to build trust, and accessibility across various devices and browsers.

System Design and Architecture: A layered three-tier architecture was adopted to clearly separate presentation, application logic, and data management for improved maintainability and modularity. The presentation layer, devel- oped using HTML, CSS, and JavaScript, pro- vides an intuitive, responsive, and visually con- sistent interface across devices. The application layer, implemented in Python Flask, manages business logic including user authentication, vehicle booking and scheduling, payment pro- cessing, and interaction with third-party APIs for maps and notifications. The data layer, based on a relational SQL database, handles storage of structured data such as vehicle list- ings, user profiles, bookings, transaction logs, and document records. Security and reliability considerations—including password hashing, SQL injection prevention, API request valida- tion, and secure payment tokenization—were integrated at each layer of the design.

Implementation, Integration, and Testing: The implementation phase involved the devel- opment of individual modules according to the design specifications, followed by their inte- gration into a unified system. RESTful APIs were created to enable seamless communica- tion between frontend and backend components. Third-party mapping APIs were integrated to assist renters in locating vehicles and navigat- ing pickup/drop-off routes efficiently. Payment modules employed tokenization and verified callbacks to ensure secure financial transac- tions. The platform underwent rigorous test- ing including unit testing, integration testing, system testing, and stress testing to validate functionality, performance, and security. Load testing confirmed system stability under high traffic scenarios, while test cases for concur- rent bookings ensured prevention of double bookings and payment discrepancies. Usability testing was also conducted to refine interface interactions and enhance overall user satisfac- tion.

IV. MODELLING AND ANALYSIS

The Wheelzy system is designed using a layered architecture, ensuring modularity, maintainability, and scalability. Each module functions independently while communicating through well-defined interfaces.

Use Case Analysis: The platform supports three primary roles: Administrator, Owner, and Renter. Owners can add vehicles, set rental prices, and define

availability schedules. Renters can search, filter, and book vehicles based on date, location, and budget. Adminis- trators oversee verification, transaction records, and system monitoring. Real-time validation ensures that bookings do not overlap and only authorized users access role-specific functions.

System Workflow and Data Flow: User inter- actions follow a secure workflow. Authentica- tion is role-specific, ensuring restricted access. Once a renter selects a vehicle, the system checks availability and validates documents before initiating the payment process. After successful payment, booking confirmations and receipts are generated and stored in the database. Frequent queries, such as vehicle searches and booking histories, are optimized with indexing and caching to reduce response time.

Database and Entity Modeling: The database schema includes entities for users, vehicles, availability schedules, bookings, and payment records. Relationships enforce ownership con- straints and ensure referential integrity. For example, a booking must reference both a valid renter and vehicle, and each vehicle is linked to a specific owner. This structure ensures consis- tency, prevents conflicts, and supports efficient query operations for the Flask backend.

System Architecture: The three-tier design separates the presentation, application, and data layers. The frontend, developed in HTML, CSS, and JavaScript, provides a responsive and intuitive interface. The application layer, powered by Flask, manages business logic in- cluding authentication, booking validation, pay- ment integration, and API communication (e.g., maps and notifications). The data layer, using SQL, handles all structured data, enforces rela- tionships, and ensures security through hashed passwords and transaction logging. Horizontal scaling and cloud deployment allow multiple instances to operate concurrently, ensuring reli- ability under high user load.

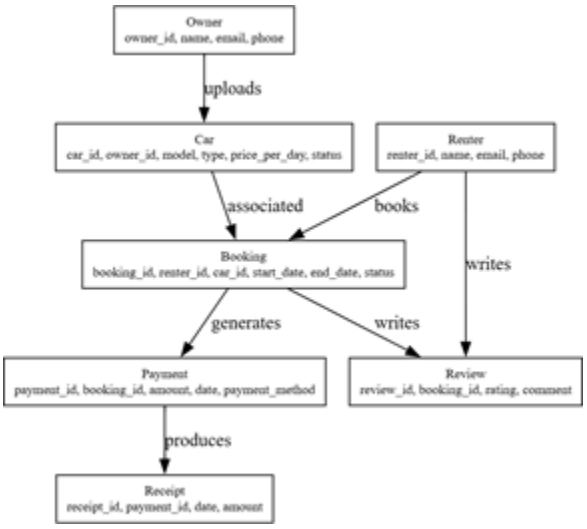

Figure 1: Entity-Relationship Diagram of Wheelzy

Figure 2: Data Flow Diagram of Wheelzy System

Figure 3: Workflow Diagram

V. RESULTS

A prototype of Wheelzy was deployed in a controlled environment to simulate real-world conditions. The system successfully prevented double bookings, maintained accurate transac- tion logs, and provided immediate booking con- firmation. Average end-to-end booking comple- tion time was measured at under two seconds, even under simulated load.

Users reported high satisfaction with the plat- form's clarity, ease of navigation, and speed. Integrated map services improved the pickup and drop-off process by providing accurate loca- tion data. Payment processing logs confirmed 100% success rates during testing, with secure verification ensuring no fraudulent transactions occurred.

VI. SCREENSHOTS

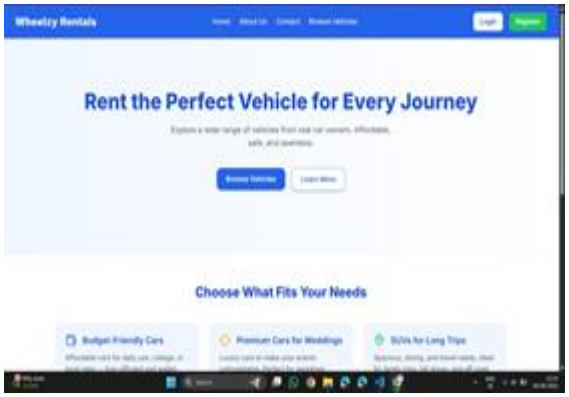

Figure 4: Base Layout Page

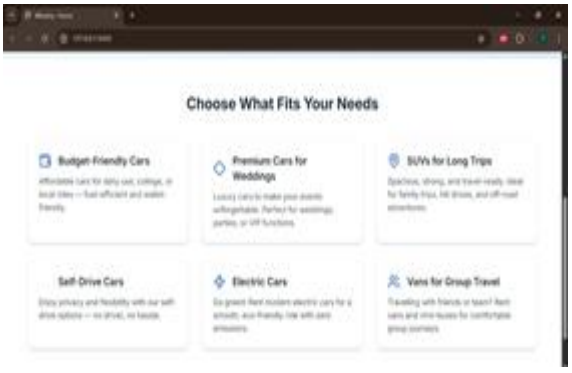

Figure 5: About Page

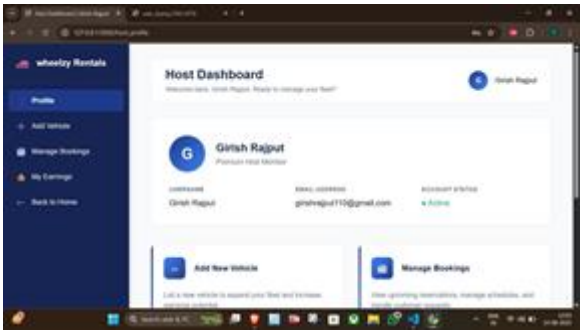

Figure 6: Dashboard Page

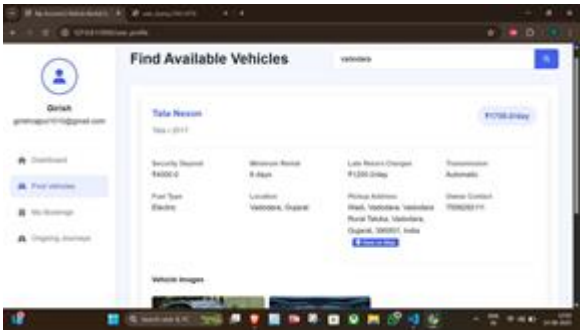

Figure 7: Home Page

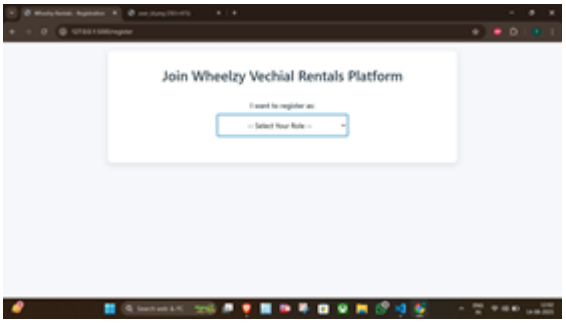

Figure 8: Registration Page

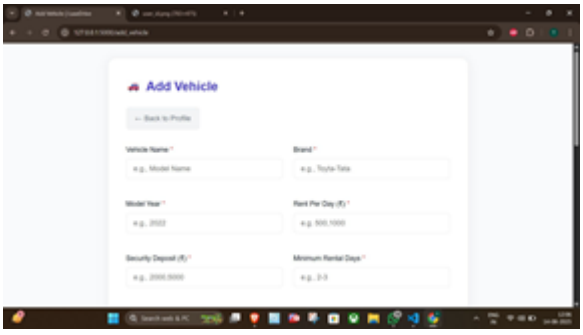

Figure 9: Add Vehicle Page

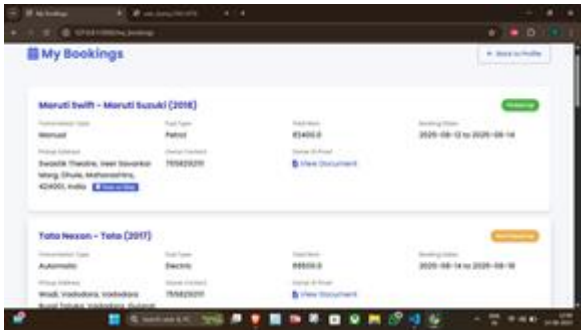

Figure 10: Booking Page

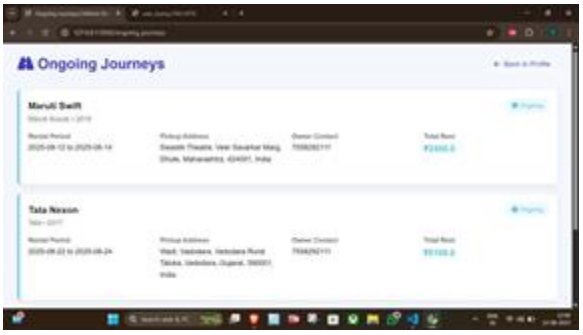

Figure 11: Booking History Page

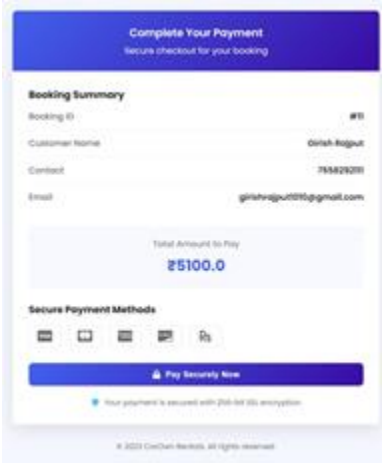

Figure 12: Payment Confirmation Page

Figure 13: Location Tracking

VII. FUTURE WORK

Looking ahead, Wheelzy has significant poten- tial to incorporate advanced technologies that will further enhance its operational efficiency, scalability, and user satisfaction. One primary direction involves the integration of AI-powered dynamic pricing models that adjust rental rates in real-time based on demand trends, histori- cal booking patterns, and seasonal variations. This would enable owners to maximize revenue while offering competitive rates to renters.

Another promising area is blockchain integra- tion for transaction logging and identity verifi- cation. By creating immutable records of every booking, payment, and verification step, the platform can provide unmatched transparency and significantly reduce disputes or fraudulent activities. Mobile application development for Android and iOS devices is also a key objective, ensuring that users can access all services on the go, including booking management, payment processing, and navigation assistance.

In addition, Wheelzy aims to integrate pre- dictive maintenance systems, particularly for electric vehicles, using IoT-enabled sensors to monitor vehicle health and notify owners before issues arise. A multilingual interface, currency conversion support, and region-specific fea- tures could make the platform viable for global deployment, opening opportunities in emerg- ing markets where shared mobility is gaining traction.

VIII. CONCLUSION

The development of Wheelzy represents a strate- gic step forward in addressing the limitations of existing car rental platforms. By combin- ing secure authentication, automated booking workflows, integrated maps, and encrypted pay- ments, the system delivers a streamlined expe- rience for both owners and renters. Its layered architecture ensures modularity, making it eas- ier to introduce future enhancements without disrupting existing services.

The testing phase confirmed the platform's reliability, processing speed, and user satisfaction levels, while also validating its potential for scaling to larger urban deployments. With the planned integration of AI-driven pricing, blockchain-based transparency, and predictive vehicle maintenance, Wheelzy has the potential to set new benchmarks in the vehicle rental industry. The project demonstrates that technology, when carefully implemented, can bridge trust gaps, reduce operational inefficiencies, and create a more sustainable mobility ecosystem.

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We also acknowledge the contributions of our peers and fellow students, whose critical re- views and testing feedback played a vital role in refining the platform. Finally, we thank Parul University for offering a learning environ- ment that motivates students to transform ideas into real-world solutions and for encouraging collaborative efforts that bridge academia and industry needs.

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