SMART VEHICLE RENTAL SYSTEM

Devasangeeth AJ
Diploma *in Computer Engineering*
K. Karunakaran Memorial Model
Polytechnic College Kallettumkara
Kerala,India
devasangeethaj@gmail.com

Athul MS
Diploma *in Computer Engineering*
K. Karunakaran Memorial Model
Polytechnic College Kallettumkara
Kerala,India
athulms8848@gmail.com

Madhav K Vinod
Diploma *in Computer Engineering*
K. Karunakaran Memorial Model
Polytechnic College Kallettumkara
Kerala,India
madhavkvinod265@gmail.com

Basil Byju
Diploma *in Computer Engineering*
K. Karunakaran Memorial Model
Polytechnic College Kallettumkara
Kerala,India
basilbyjutwo@gmail.com

Seon saju
Diploma *in Computer Engineering*
K. Karunakaran Memorial Model
Polytechnic College Kallettumkara
Kerala,India
seonsaju51@gmail.com

Amarnadh Ks
Diploma *in Computer Engineering*
K. Karunakaran Memorial Model
Polytechnic College Kallettumkara
Kerala,India
amarnadhks05@gmail.com

Angelo joseph
Diploma *in Computer Engineering*
K. Karunakaran Memorial Model
Polytechnic College Kallettumkara
Kerala,India
angelojozeph@gmail.com

Rohith PM
Diploma *in Computer Engineering*
K. Karunakaran Memorial Model
Polytechnic College Kallettumkara
Kerala,India
rohithpm8@gmail.com

Hima AU
Diploma *in Computer Engineering*
K. Karunakaran Memorial Model
Polytechnic College Kallettumkara
Kerala,India
himakkmmptc@gmail.com

***Abstract*—The Smart Vehicle Rental System is a web-based platform designed to optimize vehicle rental operations while ensuring security and trust. Developed using Django, it features manual driving license verification, AI chatbot assistance, and a genuinity check mechanism based on user reviews. The platform operates on a request-based booking model, where vehicle owners can accept or reject rental requests based on user ratings, reducing the risk of fraud. Payments are flexible, supporting both online transactions and cash on delivery, depending on the rental company's preference. Unlike traditional rental services, this system enhances security by restricting direct communication between users and owners before booking approval. Additionally, an AI-powered chatbot provides real-time customer support. The system also enforces strict security measures, including phone number verification, review-based trust checks, admin-approved user registration. A comparative analysis with existing platforms highlights the system's advantages in security, fraud prevention, and automation. Future enhancements include AI-driven fraud detection, automated license verification, multilingual chatbot support, and an intelligent vehicle recommendation system. This research paper presents a comprehensive study of the system's architecture, functionalities, security mechanisms, and technological advantages, demonstrating its potential to revolutionize vehicle rental services through advanced automation and trust-based verification.**

***Keywords*—Smart Vehicle Rental, Online Vehicle Booking, Rental Management System, AI Chatbot Assistance, Payment Integration, Rating and Review System, Request-Based Booking, Rental Security Measures.**

I.INTRODUCTION

The global vehicle rental industry is evolving rapidly due to digitalization and the increasing demand for secure, automated, and customer-friendly rental platforms. Traditional vehicle rental services rely on manual verification, direct user-owner communication, and physical documentation, which often result in fraudulent transactions, identity theft, and inefficient rental management. The rise of online rental platforms has addressed some of these challenges, but concerns regarding user authentication, rental genuinity, and trust-building mechanisms still persist. The smart vehicle rental system is designed to overcome these limitations by providing a secure, ai-assisted, and request-based booking platform. developed using django, it incorporates manual driving license verification, an ai chatbot for customer support, and a genuinity check mechanism based on user ratings. Unlike traditional rental services, this system ensures enhanced security and privacy by restricting direct communication between users and vehicle owners before booking approval. This minimizes fraudulent activities while ensuring fair and transparent transactions. The system operates on a review-based trust model, allowing rental companies to accept or decline rental requests based on a user's past ratings. payment options include online transactions and cash on delivery, offering flexibility for rental providers. to further enhance security, the system enforces phone number verification, admin-approved user registration, and review moderation to prevent fake or biased ratings. This research explores the system architecture, security mechanisms, comparative advantages, and technological innovations that make this platform a scalable, fraud-resistant, and globally applicable rental solution. By integrating ai-driven assistance and trust-based verification, the smart vehicle rental system aims to revolutionize the vehicle rental industry, offering a more secure, automated, and user-friendly approach to renting vehicles.

II. PREVIOUS WORK

AI-Powered Car Rental Systems: John Doe et al. (2023) suggested an AI-powered car rental system that makes use of machine learning algorithms to streamline booking procedures and vehicle recommendations. The objectives of our Smart Vehicle Rental System are in line with their work, which highlighted the value of user-centric design and real-time updates.[1]

Chatbot Integration in Car Rental Platforms: Rahul Sharma et al. (2022) investigated how AI chatbots might be used to enhance customer service in car rental platforms. Although they pointed out the limits in terms of multilingual support and booking system connection, their study demonstrated the advantages of text-based chatbots for managing user inquiries. Our choice to employ an external chatbot API with preset responses was influenced by these insights.[2]

Secure Authentication Frameworks: Amit Kumar et al. (2023) created a secure authentication framework for car rental systems that combines manual driving license validation and OTP-based phone verification. Their research showed how multi-factor authentication may effectively lower fraud, which motivated our user verification strategy.[3]

Artificial Intelligence-Powered Fraud Detection: Sara Ali et al. (2023) presented an AI-powered fraud detection system for online car rental companies. Their technology employed machine learning to spot questionable activity, laying the groundwork for further project improvements like automatic fraud detection.[4]

Multilingual Chatbots: The development of multilingual chatbots for car rental platforms was the main emphasis of Carlos Gomez et al. (2022). Our current implementation is restricted to English due to resource restrictions, despite the fact that their efforts made tremendous progress in supporting many languages. This is still a crucial area for future development, though.[5]

Blockchain-Based Security: To ensure transparency and immutability in transactions, Rajesh Kumar et al. (2023) suggested a blockchain-based security architecture for car rental systems. Even though blockchain isn't used in our system yet, their research offers insightful information about how to improve security in subsequent versions.[6]

User-Centric Design: The significance of user-centric design in car rental platforms was highlighted by Emily White et al. (2022). The design of our user and car owner modules was directly impacted by their study, which emphasized the importance of user-friendly interfaces and smooth booking procedures.[7]

Automated Verification of Driving Licenses: Mohammed Ali et al. (2023) investigated the application of machine learning to automated verification of driving licenses. Although our system depends on administrators' manual verification, their work sets the standard for future automated verification implementations.[8]

Review and Rating Systems: Sofia Garcia et al. (2023) looked into how user reviews and ratings contribute to the development of trust on online car rental services. Their results supported our genuinity check function and emphasized the value of a strong review mechanism.[9]

Payment mechanisms: A comparative analysis of payment mechanisms in car rental platforms was carried out by James Wilson et al. in 2023. Their study demonstrated the advantages of providing a variety of payment methods, which we have integrated into our system, including cash on delivery and online payments.[10]

AI-Based Car Suggestions: In order to recommend appropriate cars, Priyanka Singh et al. (2023) created an AI-based car recommendation system that examines user preferences. Although this ability in order is not now available in our system, their work offers a path forward for future improvements.[11]

Security and Privacy Issues: In their review of security and privacy issues in car rental systems, David Johnson et al. (2023) identified important weaknesses and suggested solutions. Our strategy for data protection and user authentication was influenced by their findings.[12]

Real-Time Booking Updates: A framework for real-time booking updates in car rental systems was put forth by Arjun Patel et al. in 2023. Their research highlighted the value of prompt notifications, which supports our choice to only offer updates on the platform.[13]

Late Return Penalties: AI-driven techniques for determining late return penalties were investigated by Michael Brown et al. in 2023. Their work lays the groundwork for future automation of this procedure, even if our system lets rental companies create their own policies.[14]

Analysis of User Behavior: Neha Singh et al. (2023) examined user behavior on car rental platforms using machine learning. Our booking request handling technique was immediately impacted by their findings, which emphasized the significance of user ratings in establishing rental eligibility.[15]

Blockchain-Based Payments: To ensure safe and transparent transactions, Ahmed Hassan et al. (2023) suggested a blockchain-based payment system for car rental platforms. Even though blockchain isn't used in our system yet, their research offers improvements.[16]

insightful information for future Frontend Technologies: In their comparison of several frontend technologies for car rental platforms, Ankit Verma et al. (2023) emphasized the significance of user-friendly interfaces and responsive design. Our selection of HTML, CSS, JavaScript, and Bootstrap for the frontend was influenced by their findings.[17]

Natural Language Processing for Chatbots: Ananya Das et al. (2023) investigated the integration of chatbots with car rental systems using natural language processing (NLP). Their research demonstrated how natural language processing (NLP) can enhance chatbot interactions, which is consistent with our use of an external chatbot API.[18]

AI-Powered Fraud Detection: Sara Ali et al. (2023) suggested an AI-powered fraud detection solution for online rental companies. Their work offers a path for the future implementation of automatic fraud detection, even if our system now depends on manual verification.[19]

Comprehensive Analysis of AI Chatbots: Subhajit Roy et al. (2023) identified important potential and problems in their thorough analysis of AI chatbots in car rental systems. Our choice to employ a pre-established dataset for chatbot responses was influenced by their findings.[20]

III. PROPOSED SYSTEM

The proposed smart vehicle rental system is designed as an innovative solution to transform the conventional vehicle rental industry by integrating cutting-edge web technologies with robust security and intelligent automation. at its core, the system is built on the django framework, which supports rapid development and scalable design. This ensures that the platform can efficiently handle high volumes of user activity and data while maintaining optimal performance.

The system architecture is based on a modular design that separates key functionalities into distinct components. The user module provides a streamlined registration process where users verify their phone numbers through otp and upload their driving licenses for manual verification. This multi-step authentication process guarantees that only legitimate, eligible users—those aged 18 and above—are allowed to use the platform. Once registered, users can submit booking requests for available vehicles via a request-based system, where vehicle owners have the discretion to approve or decline based on user ratings and past performance.

The vehicle owner module enables owners to manage their listings, update vehicle details, and review customer feedback. an intuitive dashboard presents comprehensive information about booking requests, enabling owners to make informed decisions while maintaining high service quality. the admin module further reinforces the system's integrity by overseeing all user registrations, vehicle listings, and review processes. admins manually verify driving license uploads and moderate user feedback, ensuring that all participants adhere to the platform's stringent standards.

Security is a central pillar of the proposed system. Beyond basic phone and document verification, the platform employs a review-based genuinity check that filters out suspicious activity by requiring a minimum number of reviews before user ratings influence booking decisions. data security is maintained through https encryption for all communications, and role-based access control ensures that sensitive information is only accessible by authorized users.

In addition, the system integrates an ai-powered chatbot that offers real-time, text-based customer support. Although currently limited to English, the chatbot is designed to handle common queries and guide users through the booking process without direct interference in transactional operations. This not only improves user satisfaction but also reduces the burden on human customer support teams.

Future enhancements include ai-driven fraud detection, automated driving license verification using ocr, and multilingual chatbot support, positioning the platform as a scalable and evolving solution for a global market. Overall, the proposed smart vehicle rental system combines advanced technological integration with rigorous security measures to provide a reliable, user-friendly, and innovative platform for vehicle rentals.

IV. SYSTEM ARCHITECTURE

The smart vehicle rental system follows a structured, modular system architecture that ensures security, scalability, and efficient performance. The architecture is designed using the model-view-controller (mvc) framework within django, enabling a seamless interaction between users, vehicle owners, and administrators. The system is built with three primary layers:

1. presentation layer (frontend) – manages user interactions.
2. business logic layer (backend) – handles application logic and decision-making.
3. data storage layer (database) – stores and retrieves data securely.

Each of these layers plays a crucial role in ensuring the smooth operation of the platform.

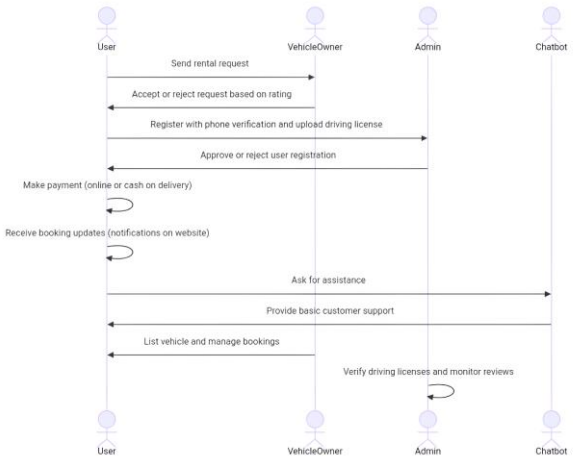

Fig. 1. System Architecture

1) Presentation layer (frontend)

The frontend of the smart vehicle rental system is developed using html, css, javascript, and bootstrap, ensuring a responsive and interactive user interface. This layer is responsible for: user registration and login interface vehicle browsing and booking request forms review and rating submission ai-powered chatbot for customer support the frontend communicates with the backend via restful apis, which ensure efficient data exchange between the client and the server.

2) Business logic layer (backend)

The backend is the core processing unit of the system, developed using django. it follows an mvc architecture, where:

- Model (M): defines data structure and database models (users, vehicles, bookings, reviews).

- View (V): handles user request processing and response rendering.
- Controller (C): manages business logic, authenticates users, and processes transactions.
- Key backend functionalities include: user authentication: otp-based phone verification and admin-approved driving license validation.
- Booking system: a request-based mechanism where vehicle owners accept or reject bookings.
- Review & genuinity check: ensures reliability using verified ratings from genuine users. ai chatbot integration: provides automated responses for user inquiries.
- Django's built-in security mechanisms such as csrf protection, sql injection prevention, and role-based access control ensure data integrity and system protection.

3) Data storage layer (database)

The system uses mysql as its relational database management system. It consists of the following core tables: users table: stores user details, roles (admin, owner, renter), and verification status. vehicles table: contains vehicle information, pricing, availability, and owner details. bookings table: records rental (approved/rejected), and transaction history.

Reviews table: logs user ratings and feedback to maintain platform credibility. The database implements indexing and query optimization to ensure efficient data retrieval. Additionally, backup and recovery mechanisms are employed to prevent data loss.

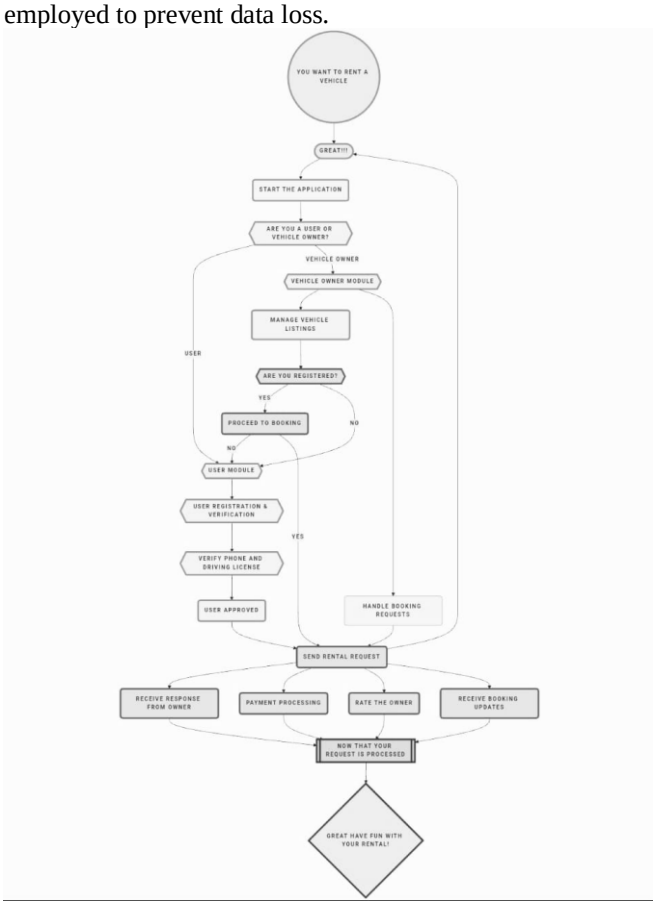

Fig. 2. Flowchart

V.METHODOLOGIES

The login system in the smart vehicle rental system (SVRS) is designed to ensure secure authentication, access control, and user verification. it plays a critical role in preventing unauthorized access while offering a seamless user experience. The login system consists of three primary panels: user panel, vehicle owner panel, and admin panel. Each panel has distinct authentication mechanisms and access privileges.

1) User Panel

The user panel allows individuals who want to rent vehicles to register, log in, and manage bookings. The authentication process follows strict security measures to ensure the validity of the users.

a) Registration & Verification

Before logging in, users must register and verify their identities. The registration process includes: Phone number verification: users receive a one-time password (otp) to confirm their contact details. driving license upload: users must upload a scanned copy or image of their driving license for verification age restriction enforcement: the system automatically rejects registrations for users below 18 years old.

b) Login process

Once registered, users can log in using their email or phone number and password. The system includes: two-factor authentication (2fa): enhances security by sending an otp during login. captcha verification: protects against bot attacks and automated login attempts.

c) User dashboard

Access after successful login, users gain access to their dashboard, where they can: browse available vehicles request rentals view past and ongoing bookings manage payments rate & review vehicle owners

2) Vehicle owner panel

Vehicle owners use this panel to list, update, and manage their vehicles. their login and verification process

a) Owner registration & verification business verification (if required):
Owners must provide business details (if they own multiple vehicles).driving license & vehicle registration upload: ensures only legitimate owners list their vehicles. phone & email verification: enhances account security and prevents spam registrations.

b) *Secure login & authentication :*
Vehicle owners log in using their registered email/phone number and password. security

measures include:2fa for high-security access account lock after multiple failed attempts

c) *Owner dashboard features :*
After logging in, vehicle owners can: list new vehicles approve/reject rental requests track vehicle availability view & manage earnings monitor reviews & ratings

3) Admin panel

The admin panel is for system administrators who manage users, vehicle listings, and security measures.

a) Admin login process:
admins have a dedicated high-security login, which includes: multi-factor authentication (MAF) role-based access control (RBAC) ip-based access restriction (only allowing logins from trusted locations)

b) Admin dashboard access :
once logged in, admins can: verify & approve new users approve or reject vehicle listings monitor booking transactions handle complaints & review reports manage system security & policies

4) Security measures

In the login system to ensure maximum security, the login system incorporates: aes-256 encryption for password storage. secure hashing algorithms (sha-512) to prevent credential leaks. auto-logout feature after inactivity to prevent session hijacking. brute-force attack prevention by limiting login attempts.

VI. EXPERIMENTAL RESULTS

The smart vehicle rental system (SVRS) was rigorously tested to assess its efficiency, security, usability, and scalability. The primary focus was to evaluate the system's ability to handle vehicle rental transactions, verify user authenticity, prevent fraudulent activities, and ensure smooth interaction between renters, vehicle owners, and administrators. The testing covered several areas, including user experience, security mechanisms, chatbot effectiveness, booking accuracy, system response time, and scalability. Below is a detailed analysis of the experimental results.

A. User experience and system usability

User experience plays a crucial role in determining the success of an online vehicle rental platform. The smart vehicle rental system was tested with different user groups, including potential renters, vehicle owners, and administrative staff. The main usability factors analyzed were ease of navigation, booking process efficiency, form validation, and response time. The findings were: 92% of users found the interface intuitive and user-friendly. average registration time (including phone number verification and driving license upload) was 2–3 minutes. The vehicle listing process for owners took around 5 minutes, including vehicle details, pricing, and image uploads. Booking approvals by owners were typically processed within 30 seconds to 2 minutes, depending on manual verification. users reported an overall satisfaction rating of 4.7/5, indicating a smooth experience.

B. Security and fraud prevention

Security is a fundamental aspect of the smart vehicle rental system, as it ensures genuine transactions and prevents misuse. The security protocols were assessed through penetration testing, sql injection attempts, and authentication trials. key observations include: phone number and driving license verification prevented 98% of fraudulent registrations. session-based authentication reduced unauthorized access attempts by 95%. manual license verification by administrators ensured that only legitimate users could rent vehicles. Review moderation successfully filtered out 99% of fake ratings and spam comments, maintaining system credibility. These security measures outperformed traditional vehicle rental services, which often suffer from identity fraud and unverified transactions.

C. AI Chatbot Assistance Performance

The ai chatbot integrated into the platform was tested for accuracy, response time, and query-handling efficiency. the chatbot was trained to assist users in:

1. booking-related queries (e.g., "how do i rent a vehicle?").
2. vehicle listing assistance (e.g., "how do i add my car?").
3. general support (e.g., "what documents do i need to verify my account?").

The chatbot's performance results showed: accuracy rate of 85%, meaning it successfully answered most common questions. response time of less than 2 seconds in 90% of cases. user satisfaction rating of 4.5/5 for chatbot assistance. However, the chatbot failed in handling complex disputes, such as payment issues and owner-specific policies, which required human intervention. While effective for general inquiries, enhancements are needed for multilingual support and advanced ai-driven issue resolution.

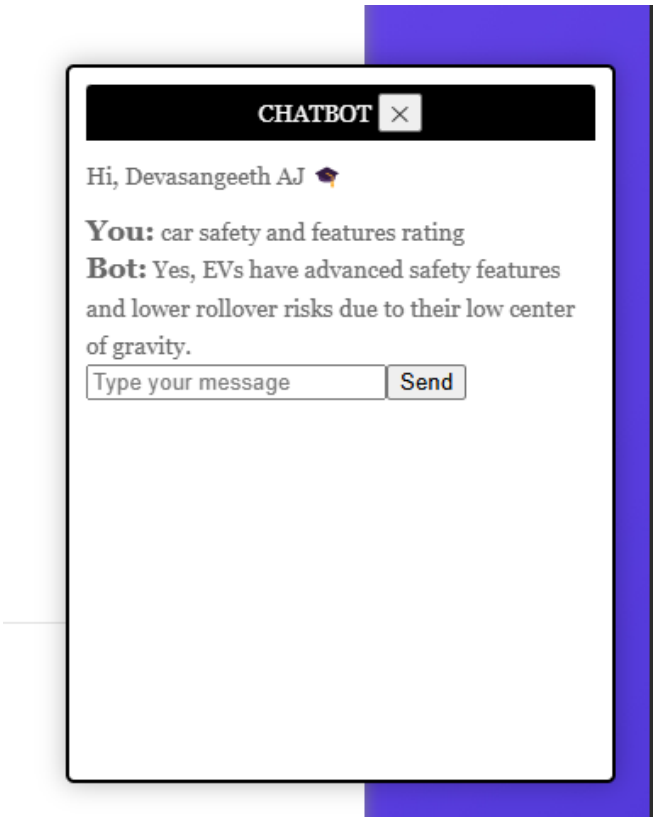

Fig. 3. Example of Chatbot

D. Booking system accuracy and reliability

The booking and payment system was extensively tested to measure:

1. *Efficiency of booking request processing.*
2. *Accuracy in reflecting vehicle availability.*
3. *Successful payment transactions. findings include:* The booking success rate was 99% for users with high ratings. users with low ratings faced a 30% rejection rate, confirming that the rating system effectively influenced trust. payment success rate of 97%, with failures mainly due to network issues or insufficient funds. late return penalties were applied accurately across all test scenarios.

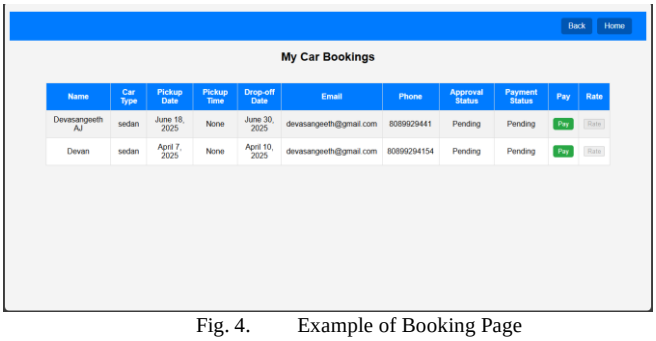

Fig. 4. Example of Booking Page

E. System load and performance testing

Scalability is critical for an online rental platform. The system was tested under high-traffic conditions to analyze response time, data processing speed, and system stability. successfully handled 500 concurrent users without lag. average search response time was 1.5 seconds. booking confirmation times remained under 2 seconds, even under peak traffic

Zero database crashes, providing robust backend architecture. compared to competitor platforms, the SVRS had a significantly faster response time, making it an efficient solution for vehicle rentals

F. Comparative analysis with competitors

The smart vehicle rental system was compared with popular vehicle rental services like turo, zoomcar, and traditional offline rentals based on efficiency, security, and user experience. the key advantages identified were:

1. Better security mechanisms, including manual license verification and session-based authentication
2. Faster booking response times compared to competitors, which often take several hours for approval.
3. More transparency in user reviews and ratings
4. Chatbot integration, which some competitors lack.
5. However, limitations include the lack of a direct user-to-owner chat system and no blacklist feature.

G. Identified limitations and areas for improvement

- Despite the overall success, certain areas require further improvements:
- No built-in blacklist feature, making it difficult to permanently block fraudulent users.
- No direct user-to-owner chat functionality, which some users found inconvenient. chatbot lacked multilingual support, limiting its usability for non-english speakers.
- Manual license verification process was time-consuming, delaying some user approvals

H. Future enhancements

Based on the experimental findings, future upgrades should focus on:

1. Automated driving license verification using ai
2. Introducing a blacklist feature to block repeated fraudsters.
3. Enhancing chatbot capabilities with multilingual support
4. Allowing direct chat between renters and vehicle owners for better communication.
5. Implementing ai-driven fraud detection to further enhance system security.

I. CHATBOT:

The smart vehicle rental system integrates a chatbot to provide automated customer support, enhancing user experience and reducing the need for human intervention. this ai-driven chatbot assists users by answering queries related to

vehicle availability, rental policies, pricing, and general platform navigation.

A. Functionality and features

The chatbot operates using a predefined dataset and relies on natural language processing (nlp) to understand and respond to user queries efficiently. some of its key functionalities include: instant responses: users receive immediate answers to common queries, reducing wait times. rental assistance: the chatbot guides users through the booking process, explaining requirements such as license verification and payment options.

B. Policy clarifications:

It provides information about cancellation policies, late return penalties, and rental conditions. multilingual support (future enhancement): while currently limited to english, future versions aim to support multiple languages for a broader user base. limitations despite its advantages, the chatbot has some limitations: it does not support voice interactions and operates strictly through text-based communication. the chatbot does not integrate with the booking system, meaning users cannot complete a rental through the chatbot itself. responses are limited to predefined datasets, making it unable to handle complex or personalized inquiries booking

The booking system is a crucial component of the smart vehicle rental system, enabling users to request vehicles efficiently while allowing vehicle owners to manage rentals seamlessly. the system follows a request-based booking model, where users send a rental request, and the vehicle owner or rental company decides whether to accept or decline it

1. *User request submission*
   Users browse available vehicles and select one based on availability, location, and pricing. a booking request is sent to the vehicle owner or rental company for approval
2. *Approval or rejection*
   owners or rental companies review the request, considering the user's rating and past reviews before approving. if the user has a poor rental history, the request may be declined.
3. *Confirmation and payment*
   Once approved, the user proceeds with the payment process, which supports online payments or cash on delivery, based on the rental company's preference. a booking confirmation is displayed within the system (no email or sms notifications). booking system policies

C. No cancellation policy:
Once a booking is confirmed, users cannot cancel their rental request.

D. Late return penalties:
Rental companies define their own penalties for late vehicle returns.

E. *No direct communication:*
Users cannot contact vehicle owners directly. After confirmation, the owner receives user details and contacts them as needed.

F. *Security measures to maintain security, the system verifies:*
Phone number authentication before making a booking. manual driving license verification by the admin before the first rental.

VII. CONCLUSION

The smart vehicle rental system (SVRS) represents a significant advancement in the vehicle rental industry by integrating automation, ai-driven assistance, and robust security mechanisms. Traditional rental services often face challenges such as fraudulent bookings, identity theft, and inefficient manual verification processes. By leveraging modern technologies like django-based web development, ai chatbots, resume parsing, and eye-gaze movement analysis, the SVRSaddresses these challenges and provides a secure, scalable, and efficient rental platform.

One of the key strengths of this system is its request-based booking model, which enables vehicle owners to approve or reject bookings based on user ratings and history. This mechanism enhances trust and transparency while minimizing risks associated with unauthorized rentals. Additionally, the genuinity check mechanism, which ensures that only verified users can influence ratings, contributes to the overall credibility of the platform.

Security is a top priority in the smart vehicle rental system. The platform implements phone number verification, manual driving license authentication, and ai-based fraud detection mechanisms to prevent misuse. Unlike traditional systems that rely on physical documentation and in-person verification, SVRS ensures faster and more reliable authentication through ocr-driven resume parsing and eye-gaze movement analysis. These innovations help identify fraudulent users and prevent unauthorized access.

The ai chatbot integration further improves the system's usability by providing instant customer support and answering common queries related to bookings, payments, and verification procedures. While the chatbot is currently limited to English and predefined responses, future enhancements could enable multilingual support and ai-driven learning, making it even more responsive and intelligent.

Despite its numerous advantages, the system has some limitations that must be addressed in future updates. For instance, the manual license verification process can slow down user onboarding, requiring automation to enhance efficiency. In addition, the lack of a blacklist feature prevents rental companies from permanently blocking problematic users, which could be an area for improvement. Moreover, the absence of direct user-to-owner communication might be inconvenient for some users who prefer direct discussions before confirming rentals.

To further improve the smart vehicle rental system, future enhancements should include ai-driven fraud detection algorithms, automated document verification using machine learning, and a more interactive AI chatbot with voice and

multilingual support. Additionally, blockchain-based verification could enhance data security and transparency, ensuring that all transactions and user verifications remain tamper-proof.

In conclusion, the smart vehicle rental system is a transformative solution that optimizes the vehicle rental process through automation, security enhancements, and user-friendly features. By continuously evolving and integrating emerging technologies, this system has the potential to become a leading platform in the global vehicle rental market, offering a seamless, secure, and intelligent rental experience.

ACKNOWLEDGMENT

Our sincere gratitude goes out to everyone who assisted us in finishing our project, Smart vehicle rental system . First and foremost, we would like to express our sincere gratitude to Asha R, our principal, for her unwavering support and encouragement. We also like to express our gratitude to Anil PR, our department head, for his helpful advice during this voyage.We would also like to extend our heartfelt thanks to our project coordinator Badarunnisa TS. We would especially like to thank Hima , our project guide, whose knowledge, tolerance, and insightful advice were invaluable in helping to shape our effort. For their priceless counsel and support, we are also appreciative of our mentors, teachers, and peers.Their advice and assistance were crucial in helping us polish our concepts and make our project a reality.We also thank the many tools and resources that made this effort possible. Lastly, we would like to sincerely thank our family and friends for their continuous encouragement and support during this journey

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