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Intelligent Vehicle Management: Harnessing Emerging Technologies for Efficiency and Sustainability

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Abstract:
Vehicle Management System provides useful features for the users (drivers) to make drive easy and use application smoothly without any friction. In today's fast-growing digital world of internet, we see often see many conflicts and disputes based on buying and selling old vehicle cause by the lack of transparency. Also, there is huge traffic in metro cities and not able to find parking areas and get fined. So, people are not able to find the available area and if available only some types vehicles can be parked like bikes and cars. There are such more problem related vehicles that exists in real world like connecting with mechanic for breakdown of vehicle. To Solve some of these problems we are intended to make a Vehicle system that helps an drive to make drive easy and reduce dispute.

Keywords: Vehicle System, Parking Availability, Mechanic Connect, Used Vehicle History.

I. INTRODUCTION

Vehicle Management System, an innovative solution for efficient vehicle management, has arisen from the growing need for better Vehicle Management System. Vehicle Management System, proposed by the author, is a comprehensive vehicle management system designed to address several pain points faced by drivers in their day-to-day lives. One such problem, as investigated by I. Betkier et al. [1], is the difficulty in finding available parking spaces, which often leads to fines. To overcome this, Vehicle Management System offers real-time information on parking availability, helping drivers to make informed decisions.

The proposed solution also aims to address the issue of lack of transparency in used-vehicle transactions, which often leads to disputes. To accomplish these goals, the research makes use of various technologies, including parking lots assignment algorithms [1], mobile-based applications for vehicle rental [2], and smart parking systems [3]. The focus is also on incorporating features to track the history of car ownership and maintenance [5], provide access to mechanic services [1], and store information about insurance brokers and related services [1]. The solution also takes into account the potential of flexible reservation systems in car sharing services [6] and the importance of preserving privacy and

accountability in car sharing services [7]. Additionally, the implementation of flexible taxi-sharing services through the Flexi-Sharing system [4] aims to reduce energy consumption and provide personalized services while preserving the interest of individuals. The solution also takes into account the importance of efficient path tracking in autonomous driving, which can be achieved through the hybrid tracker based optimal path tracking system [8]. The implementation of these solutions promises to make driving an easier and less stressful experience for drivers.

II. LITERATURE SURVEY

The literature survey of Vehicle Management System aims to provide a comprehensive understanding of the current research on Vehicle Management System. This survey covers various aspects of vehicle management such as parking lot assignment, rental vehicles, used car history, and more.
The reference papers used in this survey provide insight into current solutions for various problems related to vehicles, and help lay the foundation for the development of Vehicle Management System. The literature survey is a crucial step towards the development of an efficient and effective vehicle management system.

The literature survey for research paper [1] focuses on the parking lots assignment approach for vehicles with special parking needs. The research proposes a mathematical model to categorize vehicles and parking lots, and develops an algorithm to solve the Vehicle Routing Problem (VRP) based on graph databases. The algorithm considers traffic regulations and vehicle parameters to determine the optimal route. The solution can be extended with AI mechanisms to improve accuracy and simulate driving scenarios. The compatibility with API services and scalability makes it a promising solution for large networks or integration into existing systems. In the literature survey of the paper Vehicle Routing Problem (VRP) with Intermediate Stops for Rest and Breaks," the authors discuss the importance of considering stops along a vehicle's route, including intermediate stops for rests and breaks (ISRB). The authors focus on the impact of ISRB on urban transport, specifically the availability of parking spaces in urban areas.

The author of research paper [2] proposes a knowledge-based model for the enhancement of the vehicle rental system in Malaysia using a smartphone application called EZGO. The main goal of the study is to resolve issues faced in the traditional car rental system and improve the customer satisfaction. The study used an agile approach for the design and development of the mobile application and performed a survey of potential customers to gather their insights. The results showed that the EZGO application offers a valuable alternative option for transportation without the need for vehicle ownership in Malaysia.

In the research paper [3], the authors aimed to investigate the suitability of using taxi fleets as a means to crowd-sense on- street parking availability. The study was carried out in San Francisco and used GPS traces of 536 taxis and parking occupancy data from the SFpark project to estimate the potential quality of crowd-sensed on-street parking information for different fleet sizes and levels of sensor accuracy. The results showed that 300 taxis with 10% misdetection rates provided similar information to 486 taxis with 16% misdetection rates. The authors also found that the fleet size was not as important as the quality of the sensors, and the use of Kalman filters did not significantly improve the results. The study concludes

that using taxi fleets as a means of crowd-sensing on-street parking availability is a promising alternative to the deployment of expensive static parking sensors, and suggests that traffic management authorities should consider this method as a solution to monitor on-street parking occupancy.

The paper [4] proposes a new taxi sharing system called Flexi- Sharing to provide flexible and personalized taxi sharing services. The authors aim to address the issue of existing studies that fail to locate a pick-up/drop-off point for each individual passenger and provide personalized services. The Flexi-Sharing system considers alternative pick-up/drop-off locations, schedules a flexible sharing route, and generates a sharing schedule consisting of a set of companions, the shortest sharing route, and the best pickup/drop-off locations, all with the goal of maximizing the satisfaction of involved passengers. The results of extensive experiments conducted using one-month taxi trajectory data from Chengdu, China showed that the Flexi- Sharing system achieved a 60% sharing rate and reduced 28,000 kilometers of travel distances per hour in the city, compared to the method that delivers passengers at exact requested locations. The authors conclude that the Flexi-Sharing system provides superior sharing experiences with a satisfactory system response time.

In the paper [5], the authors J. Chen, Y. Ruan, L. Guo, and H. Lu present the design and implementation of BCVehis, a Blockchain-based vehicle history tracking service for used-car transactions in China. The aim of BCVehis is to reduce disputes caused by asymmetric vehicle information and lack of transparency in used-car transactions. The system allows vehicle owners, authorities, mechanic workshops, insurance brokers, and others to upload vehicle historical records, which are then stored on a transparent and trustworthy blockchain. The authors present the design rationale and functional implementation of BCVehis and demonstrate its effectiveness through an increased deal volume in a local used-car dealer that integrated the system into its online dealing system. This research highlights the potential of blockchain technology in reducing disputes in used-car transactions by providing transparent and trustworthy vehicle information to all stakeholders involved in the trade.

The authors of paper [6] propose a reservation scheme for a two- way station-based car sharing system. The aim of the scheme is to better manage rental reservations and encourage drivers to make better use of the existing vehicles. The reservation scheme is organized as an auction, where drivers bet for their preferred rental start time. The auction is solved using the Vickrey-Clarke-Groves (VCG) mechanism, which ensures fairness for the drivers and desired properties for the operator. The proposed scheme was tested using instances inspired by the Mobility car sharing system in Zurich, Switzerland, and the results showed that the operator could decrease their fleets with low to no impacts on the overall rental revenues. The reservation fees were also shown to partially compensate for the decrease in rental revenues for the auction users.

In the paper [7], the authors C. Huang, R. Lu, J. Ni, and X. Shen proposed architecture for car sharing services. The architecture aims to resolve the contradiction between accountability and privacy in car sharing services. Car sharing services require customers to reveal their identities (e.g. driving license) for accountability purposes, but this increases the risk of privacy breaches. To overcome this limitation, DAPA employs multiple dynamic validation servers as a substitute for a single trusted third- party

authority. Additionally, a new privacy-preserving identity management (PPIM) scheme is introduced to protect customers' identities in a distributed and dynamic manner while ensuring accountability. DAPA uses zero-knowledge proof protocol to verify customers' identities publicly while protecting their privacy. Misbehaving customers' identities can only be recovered by a majority of validation servers using adaptive verifiable secret sharing/redistribution techniques. The security analysis shows that DAPA can minimize privacy breaches and ensure accountability. Performance evaluations via simulationsb demonstrate the efficiency of DAPA in terms of computational costs and communication overheads.

The research paper [8] proposes a hybrid tracker based optimal path tracking system for autonomous driving in complex road environments. The system uses a combination of deep learning based lane detection algorithms and designated fast lane fitting algorithms to accurately track the vehicle's path in various road conditions, such as straight roads with multiple 3-way junctions, roundabouts, intersections, and tunnels. The proposed system was experimentally shown to have high performance with consistent driving comfort, even in complex road environments.

Summary of Literature Review

In the literature surveys above, several innovative Vehicle Management System have been proposed to address the challenges faced by drivers in today's fast-growing digital world. The literature surveys discussed several issues related to vehicle management such as parking lots assignment, the limitations of the traditional car rental system, difficulties in monitoring on-street parking availability, disputes caused by asymmetric vehicle information in used-car transactions, lack of transparency in buying and selling old vehicles, difficulties in finding parking spaces, and penalties associated with parking in restricted areas. To overcome these difficulties, innovative technologies such as mathematical models, AI mechanisms, smartphone applications, GPS traces, Kalman filters, blockchain technology, and flexible and personalized vehicle-sharing systems have been proposed as solutions. These technologies aim to provide efficient and effective solutions to improve the overall driving experience and reduce disputes in vehicle management.

III. METHODOLOGY

A. Input stage

User registration: The user has to register on the Vehicle Management System application to access its features. Login: If already registered, the user can log in using their credentials to access the app. Parking slot booking: To book a parking slot, the user has to add their current location and type of vehicle. Renting a vehicle: To rent a vehicle, the user has to enter the type of vehicle and current location. Mechanics service: The user needs to select their current location and find nearby mechanics. Used car buying: The owner has to upload the details of the used car for the buyer to see.

B. Output & Display

The app will display Parking space available, Rental vehicles available, Mechanics nearby, Used car history, Data related to mapping is provided by Google Map API and more. The output is displayed to the user when they use the respective feature of the app.

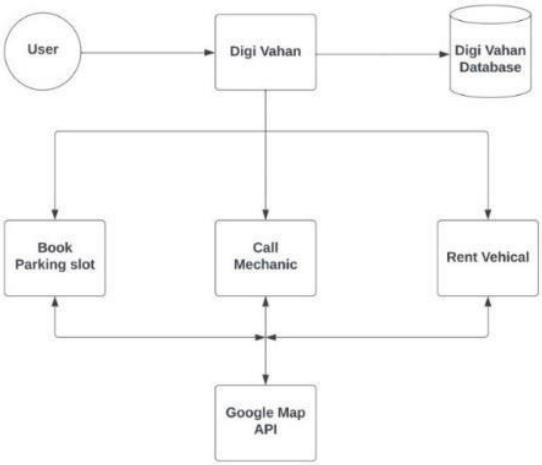

Figure 1: Block Diagram

The block diagram in Figure. 1 gives an overview of the approachtowards building a basic version of the intended features for Vehicle Management System application. The workflow for Vehicle Management System works in the following manner – Book Parking Slot - The nearest parking slot will be booked with the help of this feature of the application. Call mechanic- This feature will help to call the nearest mechanic in case of vehicle failure. Rent Vehicle- The customer can take a vehicle on rent according to his requirements. Google Map API - All the data related to mapping will be provided by google map API.

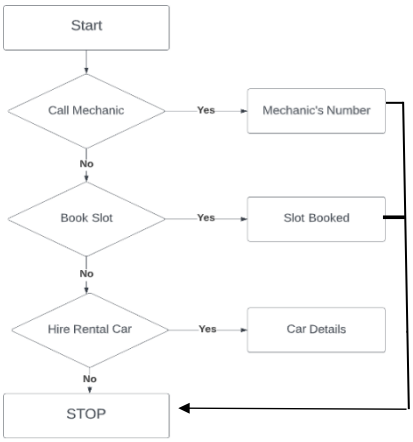

Figure 2: Flow Chart

Figure 3: Use Case Diagram

In Figure. 2, the flow chart of the application is depicted. When the user opens the app, they are presented with various features to choose from. After selection, the user enters the corresponding feature. For instance, if the user selects the mechanic feature, the app shows nearby mechanic options for the user to connect with. For the parking feature, the user inputs their current location and vehicle type, then the app displays nearby parking slots for the specific vehicle. For rental, the user selects the desired vehicle type and contacts the agent. The used car buying feature allows the owner to upload details, which are stored for buyers to view and assess the vehicle condition.

Figure-3 depicts the use case diagram which shows the interaction between the actors and the system.

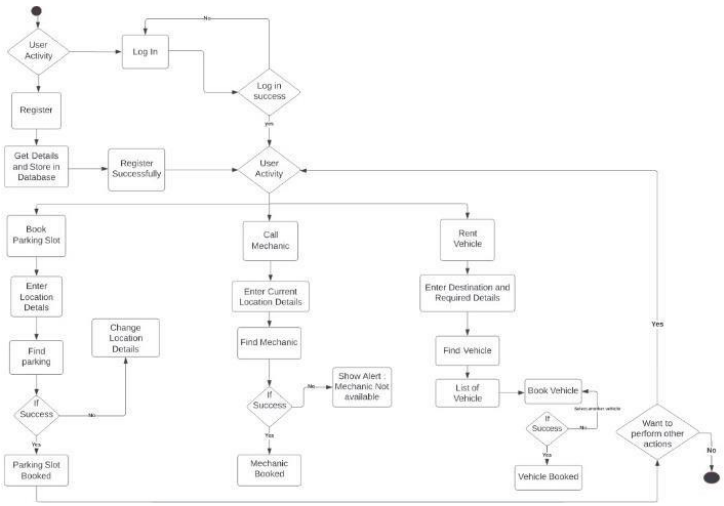

Figure 4: Activity Diagram

Figure 4 illustrates the flow of control in the system and the steps involved in executing a use case. The user's activities determine the flow of control, and the activities have a predefined flow that is executed based on certain conditions. The diagram shows the process of using the system for various vehicle-related needs, such as registering a vehicle, renewing its registration, or checking its status. The flow of control is visually represented in the diagram, allowing users to easily understand the steps involved in each use case and how they are connected

In Figure 5, a sequential flow of the system and the communication between objects is shown. The active objects or actors involved in this process are Users, Car Rental system, the services offered, the Vehicle database, and the Rental database. The sequence diagram depicts the interactions between these objects and the exchange of messages that occur to carry out the car rental process. The Users initiate the process by interacting with the Car Rental system, which then accesses the various services offered,

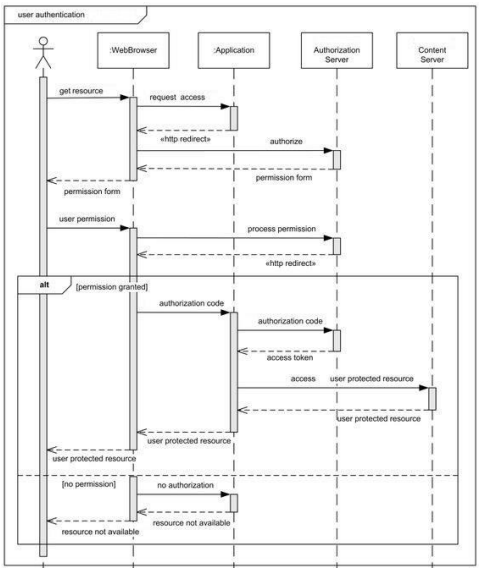

Figure 5: Sequence Diagram

In the class diagram of Figure 6, the relationship between classes is depicted. The class diagram shows the structure of the system, including the attributes and functions of each class. The class diagram represents the classes that are involved in the car rental system such as the Car Rental System, Services Offered, Vehicle Database, and Rental Database, which all interact with the System interface. This diagram provides a clear overview of the relationships between the different components of the system, making it easier to understand how they interact with each otherto deliver the desired functionality.

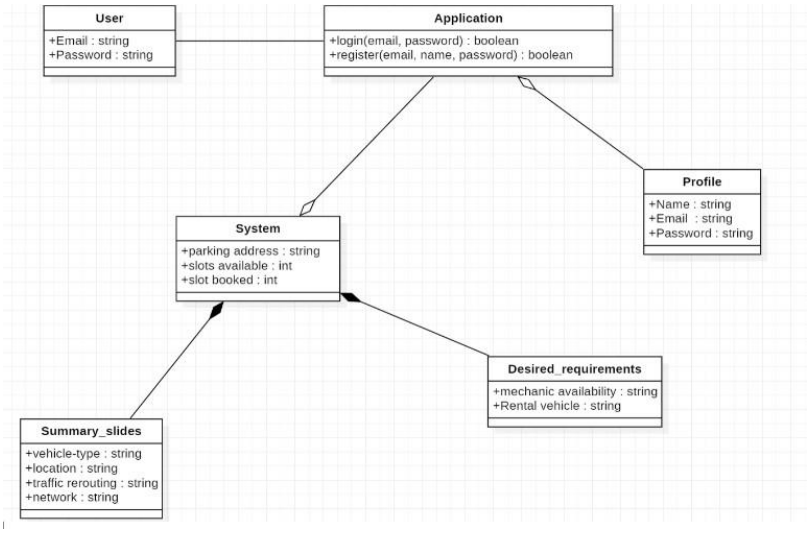

Figure 6: Class Diagram

System Components:

User Interface: The user interface will be designed using Android Studio, HTML, CSS, and JavaScript. The interface will be user- friendly, easy to navigate, and responsive to different screen sizes. **Authentication:** Firebase will be used for user authentication. The authentication module will ensure that only authorized users can access the system and perform the desired actions. **Database:** Firebase will also be used as the database for storing user data, parking slot details, vehicle rental details, mechanics' details, and used car history. The database will be designed to provide fast and efficient data retrieval and storage. **Mapping**: Google Maps API will be used for mapping and location- based services. The mapping module will display parking slot locations, rental vehicle locations, and nearby mechanics' locations to the user.

Result:

The experimental results section presents the data obtained from tests and reviews conducted on the vehicle rental system mobile application, aligning with the objectives outlined in the Introduction of this paper. Additionally, a total of 103 respondents participated in the testing process and subsequently provided review questionnaires via Google Form.

A. Result of developing the vehicles to rent online which include cars, motorcycles, and vans.

Vehicle Management System application Interface:

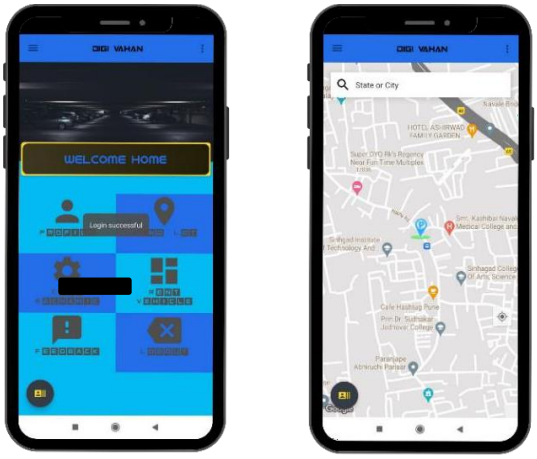

Figure 7: Authentication and user profile

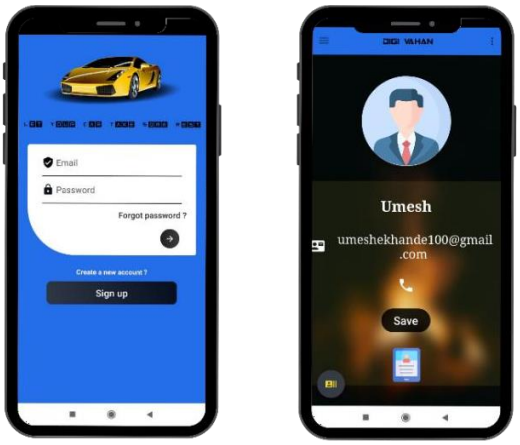

Figure 8: Nearby Available Parking Space

Figure 7 displays the login page of the Vehicle Management System mobile application, featuring the application's name, "Vehicle Management System," along with fields for entering the username and password to access the user's personal account. The page includes a login button and a forgot password option to change the user's login information for future use.

In Figure 8, the main menu page of the application is shown, providing users with various features to select from. These features include finding and booking available parking spaces, renting a vehicle, and locating nearby mechanics.

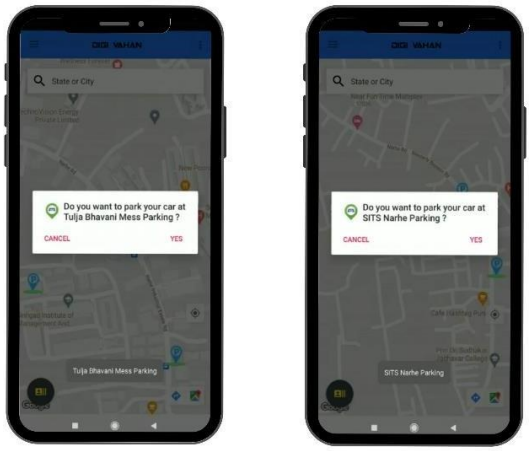

Figure 9: Booking a parking spot

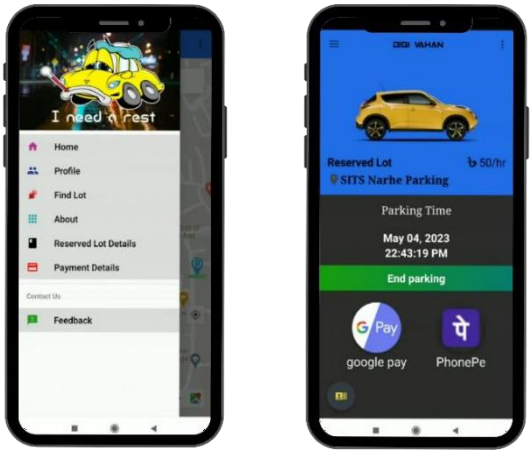

Figure 10: Payment for Parking Space

Figure 9 shows the available parking slots nearby and booking theslot from the available slot on the map. Figure 10, displays the payement method for the reserved parking slot. It also shows the parking date and time, also the online payment options

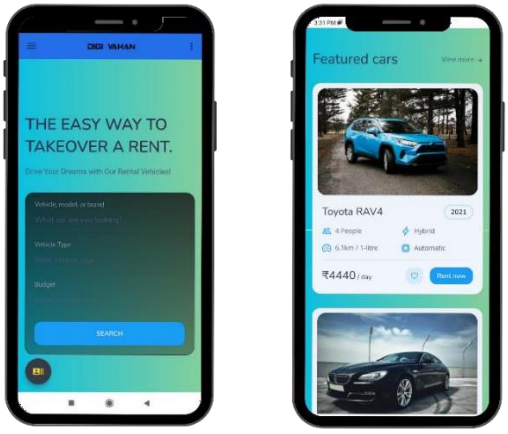

Figure 11: Nearby Mechanic available

Figure 12: Vehicle for rent

In the Figure 11, With the "Nearby Mechanic" functionality, users can effortlessly find mechanics in their vicinity or any specific location. Moreover, the application enables users to conveniently contact the mechanic of their choice, facilitating efficient communication and resolving vehicle-related issues.

Figure 12 illustrates the vehicle rental functionality of the Vehicle Management System application. Users are presented with a wide selection of available vehicles to rent, including cars, motorcycles, vans, trucks, and more. Upon selecting their desired vehicle, the application seamlessly redirects the user to the corresponding vehicle page, providing them with detailed information and options related to the chosen vehicle

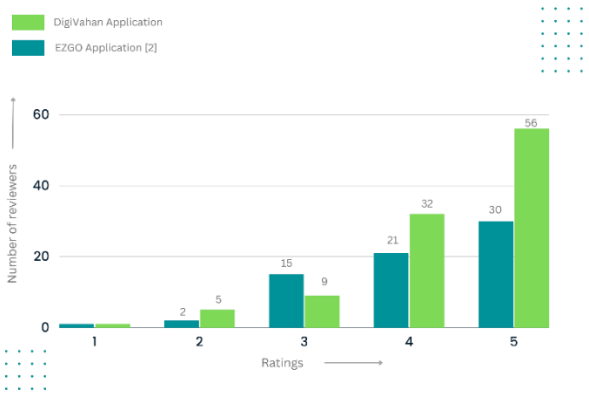

Figure 13: Bar chart of rating for user-friendliness ofapplications.

COMPARISON CHART

PROBLEM CHOSEN FROM	DRIVERS WORKING TIME	PARKING SAFETY	PARKING AVAILABILITY	PARKING SPACE	RENTAL	NEARBY MECHANIC
Our Paper	✓	✓	✓	✓	✓	✓
[1]	✓	✓	✓	✓	—	—
[2]	—	—	—	—	✓	—
[3]	—	—	✓	✓	—	—
[4]	—	—	—	—	✓	—
[6]	—	—	—	—	✓	—

Table 1: Comparison of transportation problems in this paper and related papers

Figure 13 shows the bar chart of the ratings for the user- friendliness of the mobile application. Majority answered “5” with 56 respondents, 32 respondents answered “4”, 9 respondents gave “3”, 5 respondents rate “2” and only 1 respondent answered “1”. Although there are different ratings given by the respondents, it shows that majority have good review when it comes to user-friendliness.

VI. FUTURE SCOPE & INCREMENTATIONS

Integration with payment gateways: In the future, the Vehicle Management System application can be integrated with payment gateways to enable users to pay for parking slots, rental vehicles, and mechanic services directly through the app.

Smart parking system: The app can be further improved by integrating it with a smart parking system, which will allow users to reserve parking slots in advance, reducing the chances of overcrowding.

Integration with traffic management systems: The app can be integrated with traffic management systems to provide real-time traffic updates to users, helping them plan their routes accordingly.

Integration with electric vehicle charging stations: The app can be integrated with electric vehicle charging stations, allowing users to locate nearby charging stations and plan their trips accordingly.

User reviews and ratings: The app can include a feature for users to rate and review parking slots, rental vehicles, and mechanic services, allowing other users to make informed decisions.

In-app chat support: The app can include an in-app chat support feature, allowing users to communicate with parking lot attendants, rental vehicle owners, and mechanics directly through the app.

Vehicle sharing network: The app can be expanded to include a vehicle sharing network, allowing users to share their vehicles with others in their vicinity.

Integration with vehicle telematics: The app can be integrated with vehicle telematics, allowing users to monitor their vehicle's performance and receive alerts in case of any issues.

CONCLUSION

The authors proposed the solution to the problem of vehicle related applications. This system offers real-time information on parking availability, provides a flexible and personalized vehicle-sharing system, connects drivers with mechanics in case of vehicle breakdowns and provides a blockchain-based service for vehicle history tracking. The goal of the system is to make driving easier and reduce disputes, thereby improving the overall driving experience. This system has been developed based on the real-world problems faced by drivers, such as the difficulty in finding available parking spaces and the

penalties associated with parking in restricted areas. The initial survey and requirement analysis of the features and tools required for the system has been completed, and the results are expected to provide a comprehensive solution to the challenges faced by drivers in the fast-growing digital world

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