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BUS KARO!: Live Bus Tracking System

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Abstract: ***This research paper introduces 'BusKaro!', a transformative solution aimed at enhancing public transportation accessibility and promoting environmental sustainability. In the context of pressing global concerns regarding climate change and pollution, the imperative to transition from private vehicles to public transport is underscored. However, the efficiency and reliability of public transportation systems, particularly in densely populated urban areas, remain significant challenges. 'BusKaro!' addresses these challenges by leveraging advanced GPS technology to provide real-time tracking of buses, enabling users to access accurate information about bus locations and schedules. Beyond mere convenience, 'BusKaro!' offers a comprehensive platform that empowers commuters with features such as route planning, nearby bus stop location, and service disruption alerts. Moreover, 'BusKaro!' serves as a catalyst for broader societal change. By promoting the use of public transport, it contributes to reducing traffic congestion, lowering carbon emissions, and fostering sustainable urban environments. Through a detailed examination of its design, implementation, and potential impacts, this paper elucidates the transformative potential of 'BusKaro!' in shaping the future of transportation systems. Case studies and analysis further highlight the tangible benefits of adopting 'BusKaro!' for cities and commuters alike, illustrating its role as a pivotal tool in the journey towards a more sustainable future.***

Keywords: BusKaro, User-Friendly Interface, React App, Leaflet, API, Technology, MongoDB

I. INTRODUCTION

The contemporary public transportation ecosystem is fraught with a myriad of challenges, presenting formidable barriers to efficient and user-friendly travel experiences. Among these challenges are intricate route schedules that often confound even seasoned passengers and the absence of real-time tracking mechanisms, leaving commuters in a state of uncertainty regarding bus locations and arrival times. Such deficiencies in the current system frequently result in frustrating and time-consuming journeys, undermining passenger satisfaction and potentially dissuading individuals from utilizing public transportation altogether. Moreover, the unpredictability stemming from deviations from prescribed routes by bus drivers poses not only inconveniences but also raises safety concerns and compromises service reliability. Additionally, public transportation authorities and bus operators grapple with the complexities of fleet management, facing obstacles in optimal resource allocation and service delivery. The lack of comprehensive, real-time data further exacerbates these challenges, impeding their ability to make informed, data-driven decisions that could enhance overall operational efficiency. In response to these pressing issues, our proposed system offers a multifaceted solution aimed at overcoming existing hurdles and ushering in a new era of reliable and safe bus travel. Central to our approach is the integration of real-time bus tracking capabilities, harnessing the transformative power of technology to provide passengers with up-to-the-minute information regarding bus locations and schedules. This feature not only empowers passengers to plan their journeys more effectively but also ensures adherence to prescribed routes by bus operators, thereby enhancing the safety and predictability of travel experiences. Moreover, our system leverages innovative technologies such as Leaflet for displaying interactive maps on the website, offering passengers intuitive tools for visualizing bus routes and stops. Furthermore, meticulous attention has been devoted to the creation and management of data pertaining to buses and bus stops, with information meticulously curated and stored within a MongoDB database. By leveraging advanced functionalities such as getCurrentLocation() and watchPosition(), our system enables real-time tracking of buses via the driver's device, facilitating seamless integration between the driver interface and the passenger-facing features of the platform. To enhance public transportation using technology, it's crucial to involve skilled developers who understand transit systems. Custom web apps offer many benefits for transportation stakeholders. Working with these developers allows transit authorities to create tailored solutions for improving infrastructure. These solutions include better accessibility across multiple platforms and potential revenue growth. Additionally, there are plenty of resources available for learning about web app development for public transportation. This emphasis on sharing knowledge encourages innovation and improves transportation systems. Meanwhile, the rise of on-demand transportation platforms like BusKaro signals a shift in how commuters use public transit. These platforms let users track buses, plan routes, and get real-time updates conveniently through their smartphones or computers, enhancing the overall commuter experience.

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II. PROBLEM IDENTIFICATION

The major problems that were identified include lack of a comprehensive public bus transportation system. Commuters waste enough time looking for the best bus routes and waiting for buses. It is seen that they often end up using their private vehicles which further contributes to pollution and global warming. The current static information delivery systems are inefficient and lacks user interaction. Unavailability of ticket booking platforms are also threats to environment because of paper wastage that is happening each day on all the buses.

III. LITERATURE SURVEY

There are many researches which are available on Bus Tracking platforms but there are various loop holes and complexities in these platforms. In this section, we will be discussing about previous researches and the demerits of those platforms.

A.Sonawane, K. Gogri, A. Bhanushali and M. Khairnar [1] proposed an application that provides live bus location and estimated arrival time to users. Location data is sourced from an online database updated by a separate app used by bus drivers/conductors, ensuring accuracy. Requests for bus information are handled via server-client interaction. The app continuously updates bus coordinates on the server, allowing users to track bus movement in real-time. Google's distance matrix algorithm is utilized for estimating travel time. Developed using Android Studio with a user-friendly interface, the app relies on Google Maps API for easy navigation, enhancing bus tracking for users.

B. Vincent, J. Sabu, C. Mathew, Sachin S Nair, S. B. George and Saleema D [2 proposed a system with mobile and web interfaces. The web interface caters to admin users, while the mobile interface targets parents and students. User data is stored in Google Firestore Database, enabling functions like bus selection, tracking, live video access, and report generation. Admins can manage bus fleets, add student and parent details, and adjust routes via the web portal. The system employs React Framework for UI design and Google Firestore with Firebase for secure data storage. It integrates RFID and GPS modules for student attendance tracking and real-time bus location updates, providing continuous monitoring for parents and students. Additionally, it includes activity diagrams, circuit diagrams, and login authentication features, enhancing functionality and user experience.

M. J Shah, R. P Prasad and A.S. Singh [3] proposed a system for streamlining public transportation operations comprises six modules. Firstly, RFID cards with unique identification numbers are issued to users, registered via the SBUS app, and linked to a central database for efficient management. Secondly, bus locations are tracked in real-time using SIM808 GPS GSM Modules installed on each vehicle, with coordinates updated to the central database. The third module introduces automated ticketing through RFID readers at bus entry and exit points, connected to nodemcu via Arduino Uno for database connectivity. Passengers tap their RFID cards to log journey details for fare deduction based on distance traveled, supported by fare calculation mechanisms. Additionally, encryption techniques safeguard user credentials, involving salting procedures and MD5 hashing for secure storage within the database. These modules aim to optimize public transportation operations while ensuring user security and convenience.

M. K. Deore, D. B. Raj, Srinivasan N, Vandana P and Vignesh M [4] proposed a system that involves the conversion of buses into smart buses using sensors and IoT devices, allowing for features like live tracking and distance calculation. An E-ticketing system with RFID technology manages passenger access and fare collection. IR sensors monitor seat availability, while smart bus stops with various sensors ensure user comfort and safety. An E-ticket generation machine and accident detection system further enhance the system's functionality. The user app provides services like account management, recharge, travel history, and bus details, all integrated with IoT technology for seamless operation and user convenience.

M. K. H. Rahimi, R. Mohamad*, M. Kassim, E. Abdullah, N. I. Shuhaimi [5] outlined the methodology employed in the research, detailing the hardware setup involving a NEO-6M GPS sensor module connected to a NodeMCU ESP8266. The program was uploaded to an Arduino microcontroller for execution. Additionally, it references related research on vehicle tracking and monitoring systems, showcasing various hardware and software configurations and their applications and results. The development of a bus tracking and monitoring device is depicted through a flowchart, detailing the connection of sensors and modules to transmit data, including GPS coordinates and speed, to an OLED display and Google data sheet via NodeMCU. Testing of the system was conducted along a bus route and at bus stations, analyzing data such as latitude, longitude, and bus speed.

Bo Yang, Mingyue Tang, Shaohui Chen, Gang Wang, Yan Tan and Bijun Li [6] focuses on enhancing object tracking efficiency through deep learning and convolutional filter (CF) algorithms in complex traffic scenarios. It involves designing a lightweight feature extraction network, integrating attention mechanisms, and employing online update and scale adaptation strategies. Additionally, it introduces a tracker-detector integrated approach for object tracking, addressing challenges like tracking drift and object loss. Evaluation metrics such as Peak-to-Sidelobe Ratio (PSR) aid in assessing tracking quality. The approach combines spatial constraints and filter templates for matching observed and predicted values, ensuring steady tracking. Moreover, it handles blocked and new objects by re-tracking and initializing trackers based on location and PSR calculations.

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K. I. Monica, S.Gurupriya, S.A. Magdaline [7] focuses on providing convenience through real-time bus location updates and integrated Google Maps. Development environment includes Eclipse for Android development, utilizing Android SDK and ADT Plugin. The project modules include location information and bus/route information, utilizing GPS and client-server technology. The application serves various purposes including fleet management, asset tracking, and field service management.

Mohd Hakimi Bin Zohari, Mohd Fiqri Bin Mohd Nazri [8] researched a system is to track vehicle location using GPS and GSM modules controlled by an Arduino MEGA. GPS obtains coordinates, which are then processed by Arduino MEGA and sent to users via GSM module. The process involves continuous GPS connection to satellites for coordinate retrieval and user command reception through SMS. The system updates location every minute and can be terminated by user command. Hardware includes Arduino MEGA, GPS and GSM modules, while software development involves programming with Arduino IDE. Testing revealed indoor limitations due to GPS signal obstruction, with accuracy varying from 5m to 30m outdoors

F. Al-Hilali, R. D. Luhar, M. M. Jamaal [9] aims to develop a vehicle tracking system utilizing Arduino, GPS, and GSM technologies to enhance car crash detection and reduce accidents. It includes designing a website with access control for real-time vehicle tracking and increasing awareness about accident prevention. The system involves GPS modules for location tracking and GSM modules for transmitting alerts in case of accidents. Implementation involves combining hardware and software components, including RFID technology for user authentication. Social media is used for data collection, and process modeling is employed to demonstrate system functions. The system integrates GPS and GSM technologies to track vehicles and send alerts in case of accidents, providing real-time information to users for improved safety.

R. Salazar-Cabrera, Alvaro Pachon de la Cruz , J. M. M. Molina [10] proposes implementing an ITS service for the city of Popayan, focusing on transit vehicle tracking and value-added functions such as traveler information and service management. The architecture, based on ARC-IT standards, involves modules for vehicle tracking, communication, and traveler support. Experimental results validate the feasibility of using GPS and LoRa technology for vehicle positioning and communication. The proposed service aims to improve route efficiency, reduce operating costs, and provide timely information to travelers.

K. Patel, D. Patel, N. Chaudhary, D. Thakkar, P. Savaliya, A. Mistry [11] includes features like live bus tracking, passenger density monitoring, real-time information streaming, and detection of hazards. IoT devices installed in buses collect data on environmental factors using various sensors, which is transmitted to Amazon Web Services (AWS) for storage and analysis. The system employs AWS Rekognition for passenger counting and hazard detection. A mobile app for passengers and a website for management provide real-time bus information and notifications. The APBTMS is effective in enhancing the efficiency, safety, and management of public bus transportation.

J. H..Chan, Raenu A/L, J. Iqbal [12] includes a system with login pages for users and administrators, providing functionalities tailored to their roles, such as viewing bus locations and managing user information.

M.Suresh, S.Saranya, A.Punitha, R.Kowsalya [13] utilizes technologies like GPS, GPRS, Firebase, and Google Maps API. The proposed system aims to enhance user experience by providing accurate and accessible transportation information. The conclusion emphasizes the system's potential for future scalability and its role in improving overall efficiency and convenience for passengers.

Prof. Nalawade S. R., Mr. Devrukhkar Akshay S. [14] proposed a bus tracking system that utilizes Raspberry Pi for tracking buses on Google Maps via web and Android apps. It predicts arrival times for students and enhances security with additional sensor data. The system involves a web app accessible to administrators, controlling users, buses, routes, and databases. An Android app is provided for students to track buses and their own locations for accurate distance calculations. Raspberry Pi, equipped with GSM/GPRS modules, calculates bus locations using cell tower triangulation, sending data to the web server for storage and display on maps. The system's design encompasses hardware, server, and user levels, employing technologies such as Raspberry Pi, GSM/GPRS modules, AT commands, and Google Maps API for efficient operation and enhanced user experience.

S. Desai, R. Suthar, V. Yadav, V. Ankar, V. Gupta [15] offers real-time bus location and arrival updates for passengers and enables fleet managers to oversee drivers and vehicles. It employs hardware components including GPS modules for location tracking, RFID modules for passenger data collection, and PIR sensors for detecting passengers. Data aggregation is handled by a Raspberry Pi, feeding information into a cloud database. A Python script on the IoT device interfaces with Firebase for data management. A web application, developed with React JS, accesses real-time data from the cloud using Firebase and TomTom libraries for map display and estimated time of arrival calculations. Hardware components consist of GPS tracking devices, RFID card readers, PIR sensors, and Raspberry Pi for data aggregation. Software components such as Firebase and React JS are used for front-end development and real-time data management.

After going through all the proposed models, it is seen that these researches do not adequately incorporate all the functionalities to present a comprehensive system. Moreover, the costs for developing a system with RFID or other hardware systems would impact the economy by a huge percentage given the number of buses running throughout the country. Some of the systems which are efficiently developed focuses on limited possibilities like school buses, etc. Our system presents a bigger solution with least number of resources, which are already existing.

IV. PROPOSED SYSTEM

The proposed system develops a web interface for users and bus operators. Separate interface is developed for both of them. Functionalities of the user's interface include searching bus routes, bus stops near me, arrival time for buses, bus details, ticket booking etc. Functionalities of bus operator's interface include logging in their daily in and out time, the bus number which they take with them on that day and time of departure from bus depot. All the details of tickets purchased of the specific bus number are also displayed on the operator's interface. There will also be an admin interface to select and view bus details, its location, and its adherence to the routes. This would also help in promoting safety in public buses as its seen that sometimes drivers do not obey the routes and their de-routes often cause problems to users waiting on bus stops as well as the passengers in the bus.

A. Use-Case Diagram

The following Use-Case Diagram is used to show the interaction between actors and functionalities of the website. It helps us in briefly understanding the flow of inputs and outputs from actors to webpage and webpage to actors. It is as follows –

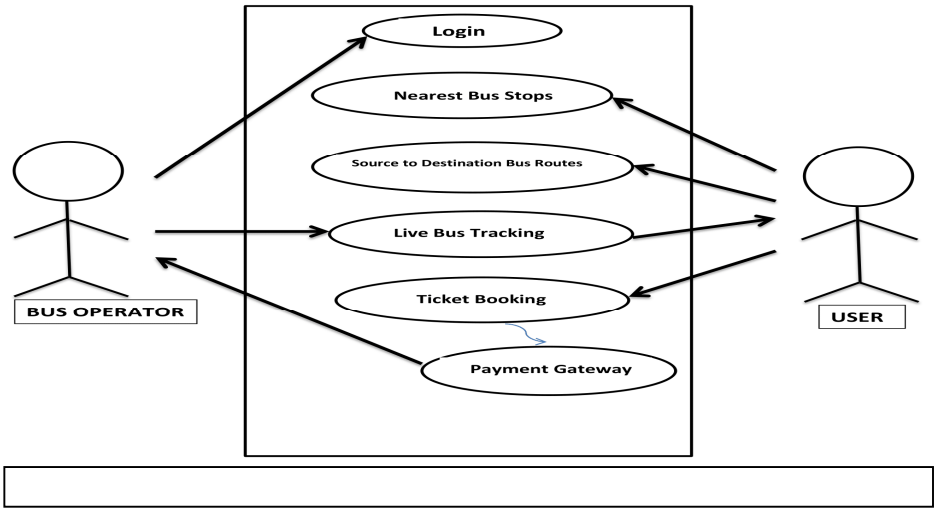


Fig. 1 Use-Case Diagram to show interaction of actors and functionalities.

B. Methodology

The development of this system epitomizes a thorough and innovative strategy aimed at elevating the bus commuting experience for users. Rooted in cutting-edge technologies, the system orchestrates a seamless and effective journey planning process. By incorporating react-leaflet for map rendering, it delivers a precise and interactive mapping interface, pivotal for users to visualize their routes and bus stops with accuracy. Live-location tracking, empowered by functions like getCurrentLocation() and watchPosition(), not only empowers users to monitor their positions in real-time but also empowers bus operators to oversee their vehicles, fostering enhanced management and coordination. The functioning of the getCurrentLocation() and watchPosition() functions is fundamental to the real-time tracking capability of the system. These functions leverage the geolocation features of modern web browsers to obtain the user's current location and track their movement continuously. Firstly, getCurrentLocation() is utilized to acquire the user's current geographical coordinates, typically in terms of latitude and longitude. This function is triggered when the user requests their current location or when the system requires it for a specific task, such as finding nearby bus stops. It accesses the device's built-in location services, such as GPS, to determine the user's precise position at that moment. Secondly, watchPosition() plays a pivotal role in providing continuous updates on the user's location. Once initiated, this function continuously monitors the device's position, periodically retrieving updated coordinates as the user moves. By establishing a persistent connection to the device's location services, such as GPS or Wi-Fi triangulation, watchPosition() ensures that the system remains aware of the user's movements in real-time.

Together, these functions enable the system to offer dynamic and accurate location tracking capabilities. getCurrentLocation() provides an initial snapshot of the user's location, while watchPosition() maintains a live feed of location updates, allowing for precise and responsive tracking. This functionality is crucial not only for users to monitor their own positions but also for bus operators to track the real-time locations of their vehicles, facilitating better management, coordination, and overall service efficiency. A standout feature of the system is its adeptness at suggesting optimal bus routes based on user-provided source and destination points. Through meticulous analysis of available routes and real-time traffic conditions, the system endeavors to furnish users with the swiftest and most convenient travel options. Furthermore, users can effortlessly locate nearby bus stops and access up-to-the-minute details regarding estimated arrival times for their preferred buses, augmenting the overall convenience and dependability of the service. Streamlining ticket booking constitutes another pivotal facet of the system, achieved through seamless integration with Razor pay for payment processing. This integration empowers users to effortlessly book and pay for their tickets within the platform, streamlining the entire journey planning process. Beneath the surface of user-facing functionalities lies a robust backend infrastructure, encompassing an extensive database and API. The database meticulously stores comprehensive information pertaining to bus stations, routes, and schedules, while the API enables swift and efficient retrieval of pertinent data such as nearest bus stops and route information. This backend infrastructure serves as the bedrock of the system, ensuring users have access to accurate and up-to-date information consistently. In essence, the system embodies a holistic approach to enhancing the bus commuting experience, seamlessly harmonizing mapping, real-time tracking, route suggestion, payment processing, and database management to furnish users with a dependable, convenient, and efficient transportation solution.

C. Activity Diagram

The three modules, Bus Operator, Admin and User integrates to an elaborate Activity Diagram showing in-depth functionalities and data-flow the website. This website allows the three modules to interact with each other in many ways. In the user module, users are provided with the ability to log into the website, where they can access real-time information about bus locations and bus stops. This functionality allows users to stay informed about the current positions of buses, facilitating better planning and decision-making for their journeys. Meanwhile, in the admin module, the system verifies user login credentials, ensuring the security of user accounts. Upon successful authentication, the server retrieves and sends the location of nearby bus stops to the user, leveraging stored data in the database. Additionally, this module is responsible for calculating the estimated time of arrival (ETA) for buses, providing users with valuable information to plan their travel effectively. Within the bus module, when a bus approaches a designated stop, the system triggers notifications to alert users. Furthermore, it continuously updates users with the live location of the bus and provides access to live feeds, enhancing the user experience and ensuring transparency in bus operations. Through these interconnected modules, the system seamlessly integrates user authentication, real-time location tracking, ETA calculation, and notification functionalities to offer users a comprehensive and reliable transportation solution.

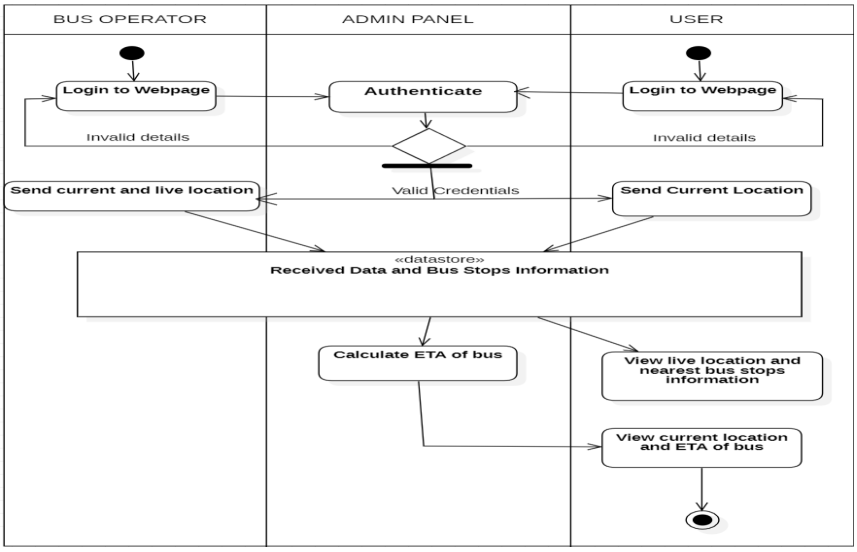


Fig. 2 Activity Diagram of BusKaro!

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V. IMPLEMENTATION AND RESULTS

The practical implementation of theories and methodologies discussed above is presented in this section. The system currently focuses on a smaller area and deals with buses, bus stops and bus routes in its proximity only because covering entire geographic area of a state or a country is impossible at prototype level.

The proposed solution manages the entire website using ReactJS and NodeJS. User authorization is done using PassportJS. In the system, a login form is generated through ReactJS to capture user or bus operator details. When the login button is clicked, the form data is transmitted to the server via the POST method in HTML. Subsequently, PassportJS is employed to authenticate the login credentials by cross-referencing them with previously stored credentials from other platforms. This process ensures the security and reliability of the login mechanism, allowing users and bus operators to access the system securely. By integrating ReactJS for frontend rendering and PassportJS for backend authentication, the system ensures a robust and seamless login experience, safeguarding user accounts and enhancing overall system security. Figure 3 shows the login page.

Upon successful login, users are directed to the homepage, which presents a range of options designed to enhance their bus commuting experience. These include features such as locating the nearest bus stops, inputting source and destination points to explore available routes and bus information, and additional functionalities. Central to the homepage is the map interface, which not only provides visual representation but also dynamically showcases the user's current location. This emphasis on mapping facilitates intuitive navigation and ensures users can easily visualize their surroundings. Moreover, the homepage boasts a user-friendly interface characterized by its simplicity and ease of use, allowing users to navigate effortlessly. Additionally, a dedicated queries section is available, enabling users to seek assistance or report any issues they encounter, thereby fostering a supportive and responsive user experience. Figure 4 shows the home page.

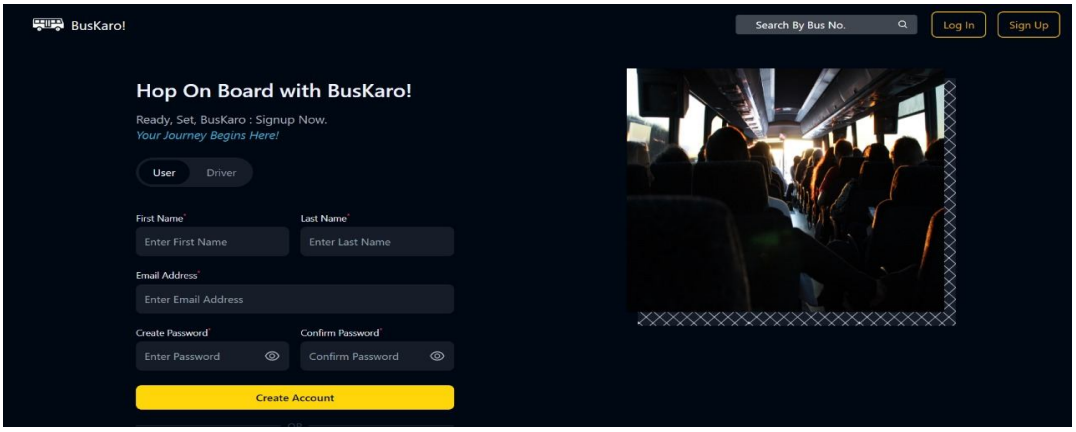


Fig. 3 Login Page

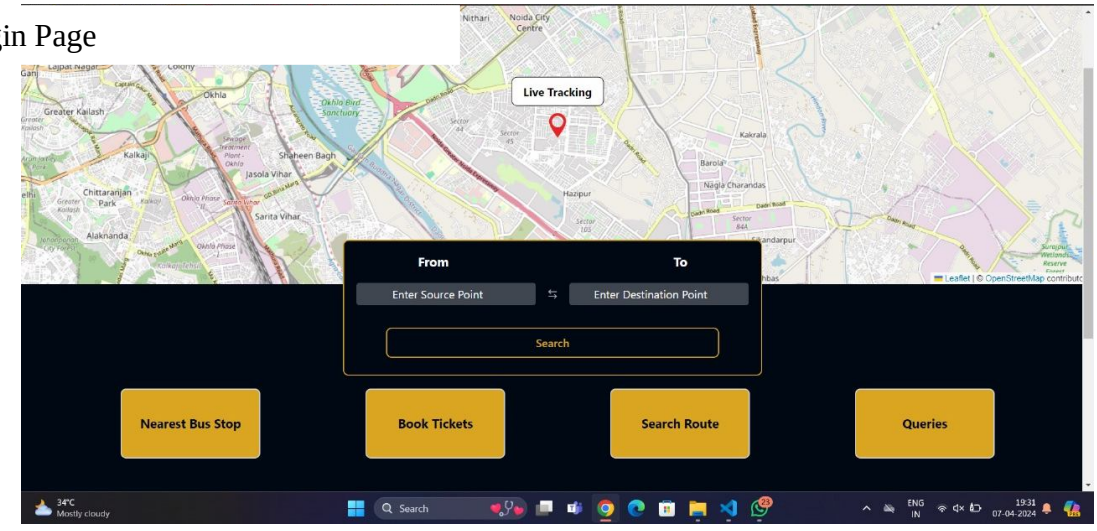


Fig. 4 Home Page

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On the nearest bus stops panel, the bus routes are visually represented, providing users with an overview of available options for their journeys. When users access the map interface, they initially see all nearby bus routes displayed randomly across the map. However, to streamline the user experience and offer relevant information, the system only showcases requirement-specific routes when a user enters their source and destination points. This targeted approach ensures that users are presented with routes tailored to their individual travel needs, enhancing clarity and efficiency in journey planning. By dynamically adjusting the displayed routes based on user input, the system optimizes the user's interaction with the map, offering a more intuitive and personalized experience.

Another engaging feature on the platform as shown in figure 5 involves a user-friendly page dedicated to booking tickets for upcoming journeys and seamlessly completing the payment process. This interactive page streamlines the ticket booking experience, allowing users to effortlessly select their desired journey details, such as travel dates, departure times, and destination points. Upon making their selections, users are guided through a smooth payment process, facilitated by secure and efficient payment gateways. This functionality enhances convenience for users, eliminating the need for traditional ticket purchasing methods and providing a hassle-free experience. Additionally, by integrating features such as seat selection and fare calculation, this page ensures a comprehensive and tailored booking experience, catering to the diverse needs of users.

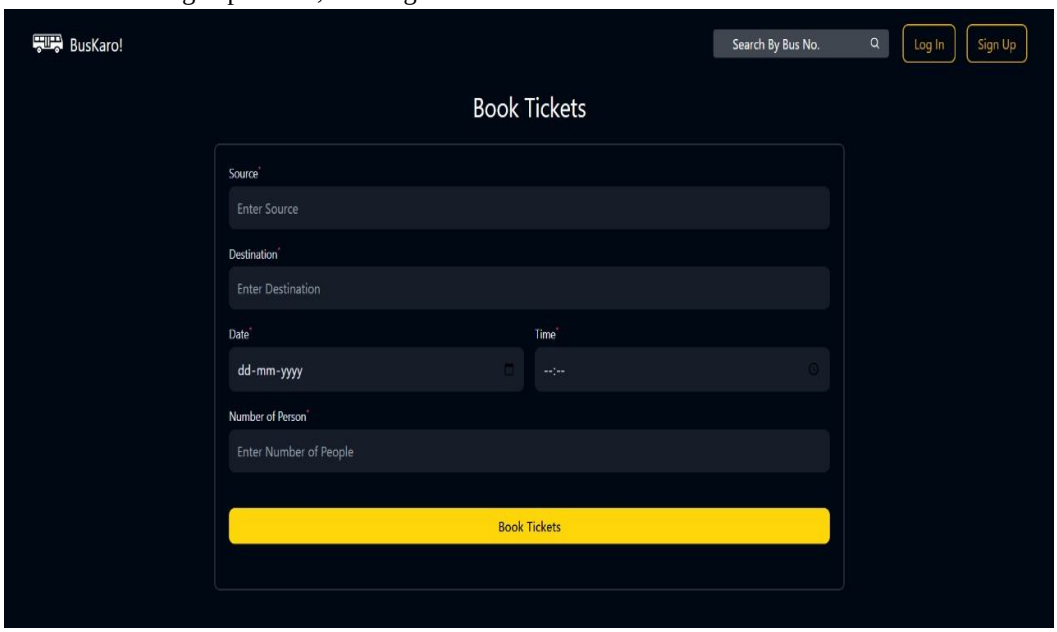


Fig. 5 Book Tickets page

VI. CONCLUSIONS

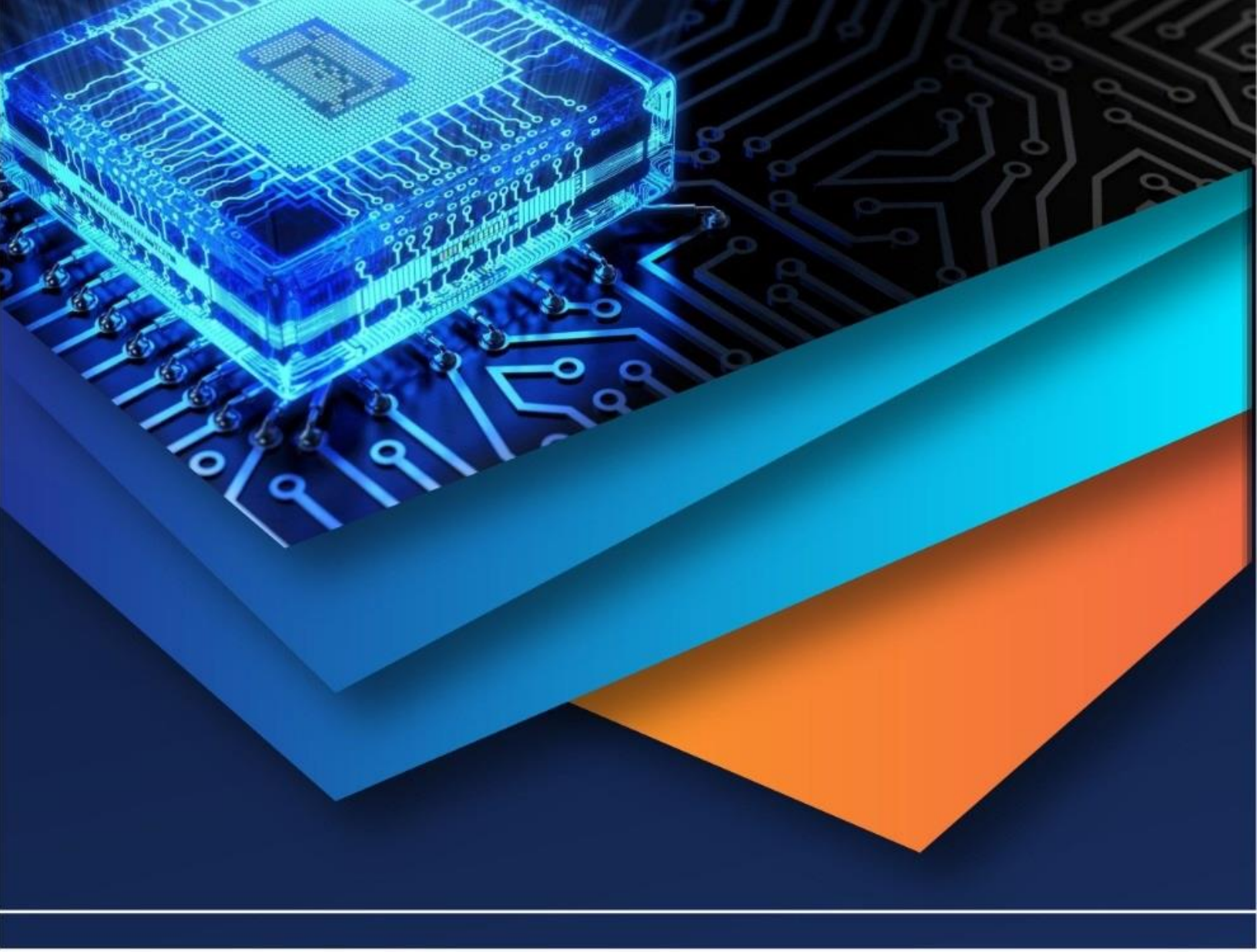
In conclusion, the research paper proposes the development of a comprehensive web interface catering to both users and bus operators, each equipped with functionalities tailored to their respective needs. The user interface facilitates convenient access to vital information such as bus routes, nearby stops, arrival times, and ticket booking. Conversely, the bus operator interface allows for logging of daily schedules, monitoring of bus details, and oversight of ticket purchases. An admin interface is also proposed to enable the selection and monitoring of bus details, enhancing safety and route adherence. Through the integration of modern technologies like ReactJS, NodeJS, and PassportJS, the system ensures secure and efficient user authentication and interaction. Furthermore, the paper highlights the pivotal role of real-time tracking functionalities, facilitated by features such as getCurrentLocation() and watchPosition(), in providing accurate location updates and enhancing overall service efficiency. Overall, the proposed system represents a holistic approach to improving the bus commuting experience, seamlessly integrating mapping, real-time tracking, route suggestion, payment processing, and database management to provide users with a reliable, convenient, and efficient transportation solution.

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