

AUTOMATED BUS SCHEDULING & ROUTE MANAGEMENT SYSTEM

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Abstract:

The **Bus Route and Scheduling Management System** is developed to improve the efficiency and reliability of bus transportation between districts. The system automates bus scheduling, monitors departures, and provides real-time tracking to passengers and bus-stand authorities. Drivers receive notifications on their devices to confirm readiness before departure, and if a schedule is rejected due to technical issues, the system automatically reschedules the next available bus to maintain smooth operations. The system integrates the **Google Maps API** to provide optimized routes based on real-time traffic conditions and accident data. Passengers can track the live location of buses and view estimated arrival times through a mobile application. Additionally, safety monitoring features alert authorities if a bus device goes offline, ensuring quick response in case of emergencies. This system helps improve operational efficiency, passenger convenience, and overall transportation safety.

Keywords — Bus Scheduling, Route Optimization, Real-Time Tracking, Smart Transportation.

INTRODUCTION

Public transportation plays an important role in connecting different districts and helping people travel safely and efficiently. However, traditional bus management systems often face problems such as delays, poor scheduling, lack of real-time information, and limited communication between drivers, passengers, and bus-stand authorities. These issues reduce the efficiency of transportation services and cause inconvenience to passengers.

The **Bus Route and Scheduling Management System** is developed to improve the management of bus transportation by using digital technologies. The system automates bus scheduling, monitors departures, and provides real-time tracking of buses.

Each bus is assigned a specific departure time, and drivers receive notifications through their devices to confirm their readiness before the journey begins. If a driver is unable to operate the bus due to technical or operational issues, the system automatically reschedules another bus to maintain smooth operations.

The system also integrates **Google Maps API** to provide optimized routes based on real-time traffic conditions and accident data. This helps drivers choose the fastest and safest routes to reach their destinations. Passengers can access a mobile application to check bus schedules, track bus locations in real time, and view estimated arrival times.

Additionally, the system includes safety monitoring features that alert bus-stand authorities if a bus device goes offline or becomes inactive. These alerts help authorities respond quickly in case of emergencies or operational issues.

Overall, the **Bus Route and Scheduling Management System** aims to enhance transportation efficiency, improve passenger convenience, and ensure safer and more reliable bus operations.

Existing System

In the existing transportation system, bus scheduling is mostly handled manually by bus-stand authorities. Buses are assigned fixed departure timings, and these schedules are rarely updated even when there are traffic delays or operational issues. Communication between the bus-stand authorities and drivers usually happens through phone calls or verbal instructions, which can sometimes lead to misunderstandings or delays in information sharing.

Passengers mainly depend on static timetables displayed at bus stands to know the bus timings. These timetables do not provide real-time updates about delays, route changes, or the current location of buses. Once a bus leaves the bus stand, there is very limited monitoring or tracking available for both passengers and authorities.

In emergency situations such as accidents, technical failures, or unexpected delays, the system relies completely on manual reporting by drivers or conductors. This lack of real-time monitoring and digital communication makes the system less efficient, causing inconvenience to passengers and making it difficult for authorities to manage bus operations effectively.

Analysis of Existing Systems

In the current bus transportation system, most of the work is done manually by the bus-stand authorities. Bus schedules are prepared in advance with fixed departure times, and these timings are usually not changed even if there are traffic delays or other problems. Because of this manual process, it becomes difficult to manage buses efficiently and sometimes buses may depart late or without proper coordination.

Passengers also face difficulties in the existing system because they mainly depend on printed timetables at bus stands. These timetables only show the planned bus timings and do not provide information about delays or route changes. Once the bus leaves the bus stand, passengers cannot know the exact location of the bus or when it will arrive, which makes the travel experience inconvenient.

Another major issue is the lack of proper communication and monitoring. Drivers and bus-stand authorities usually communicate through phone calls, which may not always be reliable. In emergency situations such as accidents, breakdowns, or technical issues, the system depends on drivers or conductors to report the problem manually. This makes it difficult for authorities to respond quickly and manage the situation effectively.

Key Technological Components and How We Connect Them

1. Frontend (User Interface)

The frontend of the **Bus Route and Scheduling Management System** provides an interactive interface for passengers, drivers, and bus-stand authorities. The mobile application is developed using **React Native with Expo**, allowing users to access the system through smartphones. The interface is designed to be simple and responsive so that passengers can easily check bus schedules, departure times, and real-time bus locations.

Passengers can search buses by selecting **places and travel dates**, view **departure and arrival timings**,

and track buses live on the map. Real-time updates such as **delay notifications and arrival alerts** are also shown to users. The frontend communicates with the backend through **REST APIs** to fetch schedule data, route information, and tracking updates. This user-friendly interface ensures that passengers receive accurate information about bus services and reduces waiting time at bus stands.

2. Backend (Application Layer)

The backend of the system is developed using **Node.js with the Express framework**, which manages all the core operations such as scheduling, bus monitoring, driver confirmation, and notification services. It processes requests from the frontend and controls the system workflow.

When bus-stand authorities create schedules, the backend stores the departure time, route, and bus details. The system also uses **traditional indexing and time-based scheduling methods** to manage bus departures efficiently. If a bus is delayed or unavailable, the backend automatically assigns **alternative bus timings** and updates the schedule accordingly. The backend also manages **automatic date changes for the next day's schedule and resets timing at midnight** to maintain continuous operations.

3. Database Management

The system uses **MongoDB** as the primary database for storing bus schedules, driver information, routes, and user details. MongoDB provides a flexible **NoSQL database structure**, allowing efficient storage and quick retrieval of data such as bus locations, route details, and scheduling information.

Each bus, route, and schedule entry is stored in the database with unique identifiers. Bus-stand in-charges can update bus information, assign routes, and manage schedules through the dashboard. The database also maintains historical data such as past schedules, delays, and bus performance records,

which can help authorities analyze transportation efficiency.

4. Real-Time Tracking System

The system provides **real-time bus tracking** using GPS location data and **WebSocket communication**. When a bus starts its journey, the driver's device continuously sends location coordinates to the backend server. These coordinates are transmitted using **socket-based real-time communication**, ensuring that location updates are delivered instantly.

Passengers and authorities can view the bus location on a map in real time. The system also calculates **estimated arrival time (ETA)** based on the bus's current speed and route conditions. This real-time tracking improves transparency and helps passengers plan their travel better.

5. Route Optimization & Mapping services

The system integrates mapping technologies such as **Google Maps API, Open Source Routing Machine (OSRM), and LocationIQ** to provide accurate routing and navigation.

These services help determine the **shortest and fastest routes** for buses based on real-time traffic conditions. If there is heavy traffic, road closures, or accidents, the system can suggest alternative routes to the driver. Map visualization also helps passengers and administrators view bus movement clearly. This routing technology improves travel efficiency and reduces delay.

6. Notification & Alert System

The system includes a **notification and alert module** to keep drivers, passengers, and authorities informed. Notifications are triggered when important events occur, such as:

- Bus departure alerts
- Delay notifications
- Late arrival alerts on the dashboard
- Schedule updates or route changes
- Emergency or device disconnection alerts

If a bus arrives late or fails to send location data, the **dashboard automatically notifies the bus-stand in-charge** so that corrective action can be taken. These notifications ensure effective communication between all stakeholders.

7. Administration Dashboard

The system provides a **web-based dashboard for bus-stand authorities** to manage operations. Through this dashboard, administrators can:

- Assign buses to specific routes and cities
- Set departure and arrival timings
- Monitor live bus locations
- Receive delay or emergency alerts
- Manage schedules and alternative bus timings

The dashboard gives authorities complete control over bus operations and helps them manage transportation services efficiently.

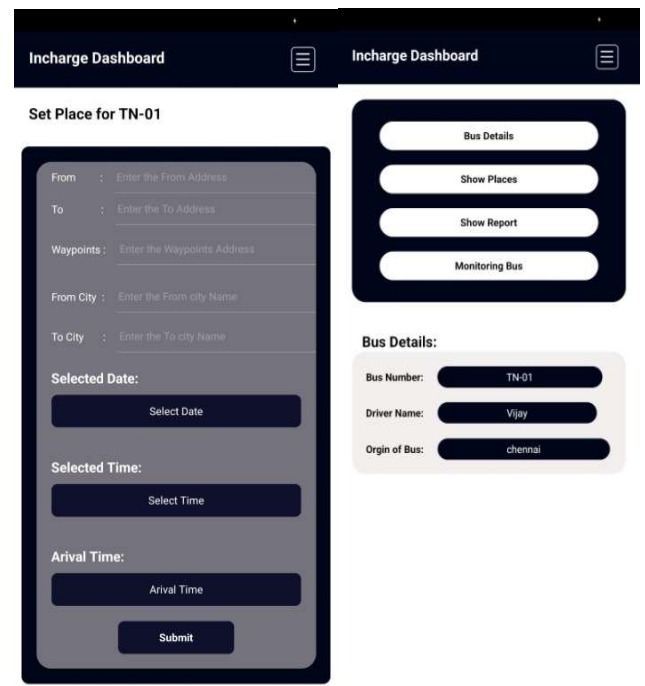
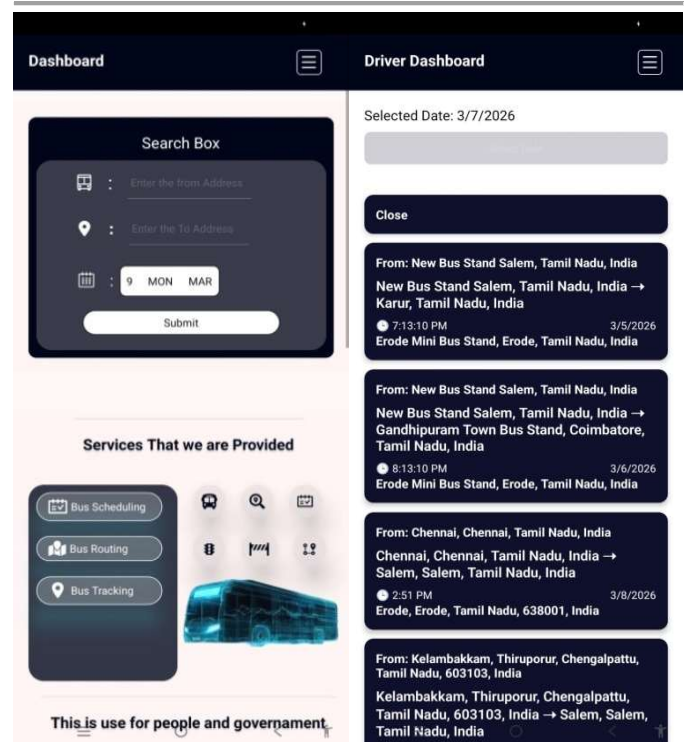
8. System Integration & Workflow

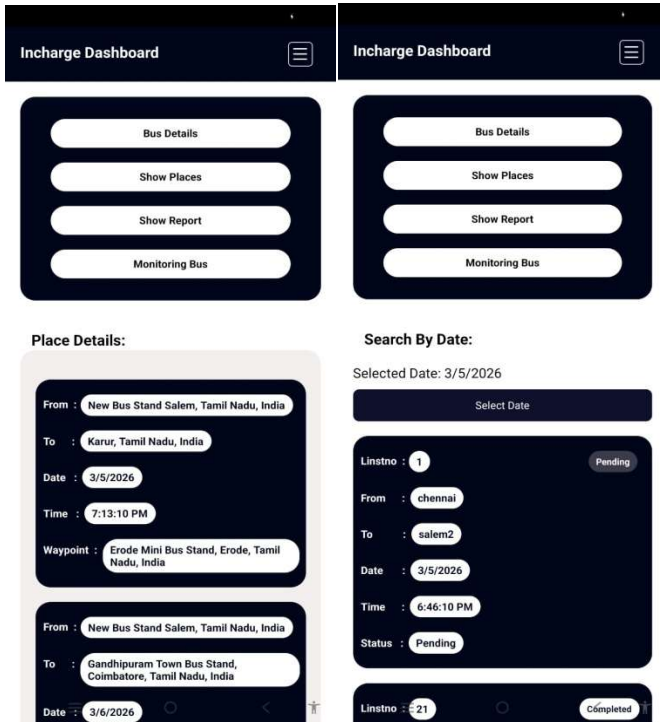
All system components work together to provide a seamless transportation management platform. Bus schedules are created by authorities through the dashboard and stored in the database. Drivers receive schedule notifications on their devices and confirm readiness before departure.

Once the bus begins its journey, the GPS location is continuously sent to the backend server using sockets, and passengers can track the bus in real time through the mobile application. If delays or issues occur, the system automatically updates schedules and sends notifications to users and administrators.

This **end-to-end integration** improves bus scheduling, monitoring, communication, and

passenger experience. The system’s modular architecture also allows future enhancements such as AI-based route prediction, traffic analysis, and smart transport management.





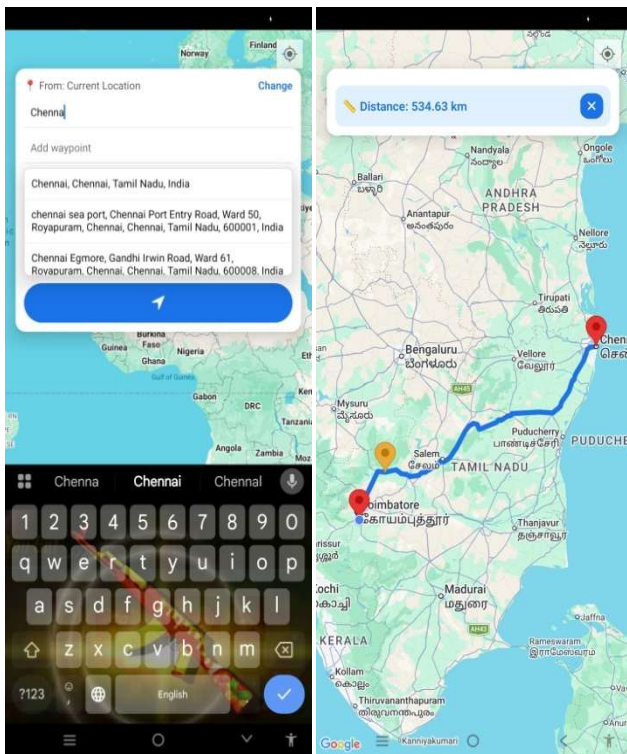
Proposed System

The proposed Bus Route and Scheduling Management System is designed to improve the efficiency, reliability, and safety of public bus transportation by using digital technologies and real-time monitoring. Unlike the traditional system, this solution automates bus scheduling, route management, and communication between drivers, passengers, and bus-stand authorities. The system provides a centralized platform where authorities can manage bus operations, monitor live bus movements, and update schedules when necessary.

In the proposed system, bus schedules are created and managed digitally by bus-stand authorities through an administration dashboard. Each bus is assigned a specific route, departure time, and destination. Drivers receive notifications on their devices before departure and can confirm their availability. If a bus is delayed or unavailable, the system automatically adjusts the schedule and assigns an alternative bus to ensure continuous service. The system also automatically updates schedules for the next day and resets timing at midnight to maintain smooth daily operations.

The system integrates Google Maps API, OSRM, and LocationIQ for route optimization and navigation. These technologies help drivers select the fastest and safest routes based on real-time traffic conditions. Passengers can track buses in real time through a mobile application developed using React Native, where they can view bus departure times, arrival times, and live bus locations. The system also includes a notification mechanism that alerts passengers and authorities about delays, late arrivals, or route changes.

Additionally, the proposed system enhances safety and monitoring by continuously tracking bus locations using GPS and real-time socket communication. If a bus device goes offline or fails to send location updates, the system sends an alert to the bus-stand in-charge through the dashboard. Overall, the proposed system improves



transportation management by providing automated scheduling, real-time tracking, better communication, and improved passenger convenience.

System Components

User Interface (Frontend)

The Bus Route and Scheduling Management System provides a mobile application for passengers and a dashboard for bus-stand authorities. The frontend is developed using **React Native**, which allows users to access bus information easily through smartphones. Passengers can search buses by selecting places and travel dates, check departure and arrival times, and track the live location of buses on a map. The interface is designed to be simple, responsive, and user-friendly so that passengers can quickly access transportation information and receive updates about delays or schedule changes.

Backend (Server & Application Logic)

The backend of the system is developed using **Node.js with the Express framework**, which manages all the core operations of the application. It handles bus scheduling, route management, driver confirmation, and communication between system modules. The backend processes requests from the frontend and manages scheduling operations such as assigning buses, adjusting schedules during delays, providing alternative bus timings, and automatically updating the next day's schedule. It ensures smooth coordination between drivers, passengers, and administrators

Database

The system uses **MongoDB** as the primary database for storing bus schedules, routes, driver details, and user information. MongoDB provides flexible and efficient data storage that supports fast retrieval of information required for real-time tracking and scheduling. All bus operations data, including departure times, route assignments, and historical records, are stored in a centralized database,

allowing authorities to manage transportation services efficiently.

Authentication & Security

To ensure system security and data protection, the system implements secure authentication and role-based access control. Different users such as passengers, drivers, and bus-stand authorities can access only the features relevant to their roles. Secure login systems and encrypted communication between the frontend and backend help protect sensitive data and prevent unauthorized access to transportation information..

Real-Time Tracking & Notification System

The system includes a real-time tracking and notification feature that allows passengers and authorities to monitor bus movement. GPS location data from buses is continuously transmitted to the server using socket-based communication, enabling live tracking on the map. Passengers receive notifications about bus departures, arrival times, delays, and route changes, while authorities receive alerts if a bus is running late or if the tracking device stops sending data.

Scheduling & Workflow Management

The scheduling module manages bus departures and ensures efficient workflow in transportation operations. Bus-stand authorities can assign buses to routes and set departure times through the system. If a bus becomes unavailable or delayed, the system automatically reschedules the next available bus and updates the timetable. The system also supports automatic schedule updates for the next day and resets scheduling data at midnight to maintain continuous daily operations.

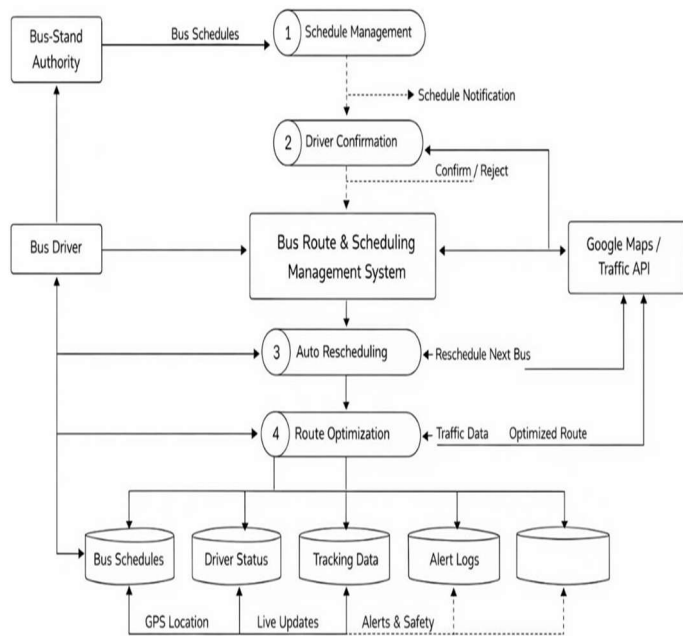
Administration Dashboard

The system provides a centralized dashboard that allows bus-stand authorities to monitor and control transportation activities. Through the dashboard,

administrators can manage bus schedules, assign buses to routes, track live bus locations, and receive alerts for delays or operational issues. This dashboard improves operational control and helps authorities manage bus services more efficiently.

Cloud Infrastructure

The Bus Route and Scheduling Management System can be deployed on cloud infrastructure to ensure reliable performance and scalability. Cloud hosting provides secure data storage, system availability, and the ability to support multiple users simultaneously. Regular backups and system monitoring help maintain data safety and ensure that transportation services remain uninterrupted.



Advantages

1. Increased Efficiency

The Bus Route and Scheduling Management System improves operational efficiency by automating bus scheduling, route management, and monitoring processes. Instead of manually managing bus timetables, bus-stand authorities can digitally assign buses, routes, and departure times through the system. Automatic scheduling features, including

alternative bus timing and daily schedule resets, help maintain continuous operations and reduce human errors. This automation ensures that bus services run smoothly and efficiently..

2. Real-Time Tracking and Transparency

The system provides real-time bus tracking using GPS and socket-based communication. Passengers and bus-stand authorities can view the live location of buses, estimated arrival times, and departure schedules through the mobile application. This transparency helps passengers plan their journeys better and reduces uncertainty about bus arrivals, improving trust in the transportation system.

3. Optimized Route Management

By integrating mapping services such as **Google Maps API, OSRM, and LocationIQ**, the system helps drivers select the fastest and safest routes. These services analyse traffic conditions and accident data to provide optimized paths for buses. This reduces travel time, avoids congestion, and improves overall transportation efficiency.

4. Improved Communication and Monitoring

The system enhances communication between drivers, passengers, and bus-stand authorities through notifications and dashboard alerts. Drivers receive schedule confirmations before departure, while passengers receive updates about bus departures, delays, and arrival times. Authorities can monitor bus movements through a centralized dashboard and respond quickly if operational issues occur.

5. Emergency Detection and Safety

The system improves safety by continuously monitoring bus location and device connectivity. If a bus device goes offline or stops sending location data, the system automatically sends alerts to the bus-stand in-charge. This allows authorities to quickly investigate the situation and take action in case of emergencies, accidents, or technical failures.

6. Better Passenger Experience

Passengers benefit from convenient access to bus schedules, live tracking, and arrival information through the mobile application. They can select travel locations, check available buses, and monitor bus movement in real time. These features reduce waiting time at bus stands and improve the overall travel experience.

7. Efficient Transportation Management

Bus-stand authorities can manage all transportation activities through a digital dashboard. The dashboard allows administrators to assign buses to routes, monitor live operations, manage schedules, and receive alerts about delays or issues. This centralized management system simplifies transportation operations and improves service reliability.

Conclusion

The **Bus Route and Scheduling Management System** improves public transportation by automating bus scheduling, providing real-time tracking, and optimizing routes. It helps passengers access accurate bus information and allows authorities to monitor operations efficiently. Overall, the system reduces delays, improves communication, and ensures more reliable transportation services.

In addition, the system supports better decision-making through centralized data management and API-based integration between system components. It ensures seamless coordination between passengers, drivers, and administrators while maintaining operational efficiency. The scalable design of the system also allows future enhancements such as advanced analytics, smart route planning, and improved transportation management solutions.

References

- [1] Zhou, J., Li, X., & Wang, Y. (2024). Smart public transportation management system using real-time GPS tracking and route optimization. *IEEE Access*, 12, 45821–45834.
- [2] Singh, R., & Sharma, P. (2023). Real-time bus tracking system using GPS and mobile applications. *International Journal of Engineering Research and Technology (IJERT)*, 12(4), 556–560.
- [3] Khan, M. A., & Rahman, S. (2022). Intelligent transport systems for smart cities: A review of technologies and applications. *Journal of Transportation Technologies*, 12(2), 87–102.
- [4] Hossain, M. A., & Islam, M. K. (2023). Development of a GPS-based bus monitoring system. *International Journal of Computer Applications*, 185(15), 22–28.
- [5] Khanna, A., Sah, A., Bolshev, V., Jasinski, M., Vinogradov, A., & Leonowicz, Z. (2021). *Sustainability*, 13(21), 11840.
- [6] Google Developers. (2024). *Google Maps Platform Documentation*. Available: <https://developers.google.com/maps>
- [7] Project OSRM. (2024). *Open Source Routing Machine (OSRM) Documentation*. Available: <https://project-osrm.org>
- [8] React Native Community. (2024). *React Native Official Documentation*. Available: <https://reactnative.dev/docs>
- [9] Node.js Foundation. (2024). *Node.js Official Documentation*. Available: <https://nodejs.org/en/docs>
- [10] MongoDB Inc. (2024). *MongoDB Database Documentation*. Available: <https://www.mongodb.com/docs>