

# **Smart Bus Route Optimization and Duty Allocation System Using Real-Time Data**

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**Abstract:** *Public transport systems often struggle with inefficient route planning and uneven duty allocation due to manual processes. This paper presents a Smart Bus Route Optimization and Duty Allocation System that aims to improve overall transport efficiency by using real-time data such as traffic conditions, passenger demand, and vehicle availability. The system supports administrators in managing buses, drivers, and routes through a centralized interface. It also helps in assigning duties to drivers in a balanced manner, considering their availability and working hours. Passengers can access route and timing information easily, which reduces uncertainty and waiting time. The proposed solution is implemented using Angular for the frontend, .NET Web API for backend operations, and SQL Server for data storage. The system minimizes manual effort, improves decision-making, and contributes to better service quality in public transportation*

**Keywords:** *Public transport*

## **I. INTRODUCTION**

Public transportation plays an important role in everyday life, especially in urban and semi-urban areas. A well-managed bus system can make travel more convenient, economical, and reliable. However, in many places, route planning and duty scheduling are still handled manually, which often leads to inefficiencies. Manual systems take more time and are more prone to errors. For example, buses may follow longer routes even when shorter alternatives exist, or some routes may experience overcrowding while others remain underutilized. Similarly, driver duty allocation may not always be balanced, leading to uneven workloads. To overcome these challenges, there is a need for a system that can make use of available data and assist in better planning. The proposed system focuses on improving route selection and duty assignment in a structured and practical way. Users can view bus routes, timing, and availability through simple interface. Drivers can view assigned duty schedule. The system helps reduce delay and improve transport service quality. This project is developed using modern technologies such as Angular for frontend, .NET Web API for backend, and SQL Server for database.

## **II. RELATED WORK**

Several efforts have been made to improve public transport systems through digital solutions. Some systems use GPS to track buses, while others focus on maintaining digital records of routes and schedules. These approaches reduce manual work to some extent. However, many of these systems still depend on fixed routes and do not adjust dynamically based on changing conditions such as traffic or passenger demand. In addition, duty allocation is often handled separately and lacks proper optimization. The proposed system attempts to bring these aspects together into a single platform that supports both route optimization and duty management.



### **III. LITERATURE REVIEW**

1. Driven Bus Boarding Demand Prediction for Real-Time Public Transport Optimization Authors: SK. Mahboob Basha, Nidanousheen, K. Anusha, E. Sathwika Reddy

Explanation:

This paper uses AI and machine learning algorithms such as SVM and Deep Neural Networks to predict passenger boarding demand using real-time transport data.

Additional Issues:

Needs accurate real-time passenger data for better prediction results.

2. Transportation Route Optimization Using Modern Technologies

Authors: Puneeth Y. M., Mithun Dolthody Jayaprakash

Explanation:

This study uses GPS and traffic monitoring systems to find shortest and efficient routes. Route optimization reduces travel time, fuel cost, and improves transport performance.

Additional Issues:

System depends on real-time traffic and GPS accuracy.

3. Driven Optimization for Efficient Public Bus Operations

Authors: Cheng-Yu Ku, Chih-Yu Liu, Ting-Yuan Wu

Explanation:

models analyze passenger demand and route data to generate optimized bus schedules. It improves operational efficiency and reduces transport cost. Additional Issues:

Requires continuous data updates for accurate results.

4. Optimization of Bus Routes in Small and Medium-Sized Cities

Authors: Hanbo Wei, Chengming Zhu

Explanation:

This research improves route planning using analytical methods based on passenger demand and traffic conditions. It reduces travel time and increases passenger satisfaction.

Additional Issues:

Requires proper data collection for accurate route optimization.

### **IV. PROBLEM STATEMENT**

In many transport systems, manual planning of routes and driver duties leads to several issues. Some routes become overcrowded, while others are underutilized. Drivers may receive uneven workloads, which affects efficiency and coordination. Passengers also face difficulties due to lack of clear and timely information about bus schedules. These problems highlight the need for a system that can organize operations more effectively and make better use of available resources. Due to lack of proper planning and real-time updates, the transport system becomes less efficient. Therefore, there is a need for a smart system that can organize bus routes and assign duties in a better and more systematic way.

### **V. PROPOSED SYSTEM OVERVIEW**

The proposed Smart Bus Route Optimization and Duty Allocation System provides an organized way to manage bus transport services. The system helps in selecting suitable bus routes based on distance, travel time, and passenger demand. It also assigns duties to drivers based on their availability and schedule. Admin can manage buses, drivers, and routes using a dashboard. The system provides a structured approach to managing bus operations. It considers factors such as distance, travel time, and demand while selecting routes. Driver duties are assigned based on availability and



scheduling requirements. Administrators can manage all transport-related data through a dashboard. At the same time, passengers can check route details and timings through a simple interface. All information is stored in a database, which helps maintain records and generate useful reports for analysis.

## **VI. SYSTEM ARCHITECTURE**

The Smart Bus Route Optimization and Duty Allocation System is a web-based platform that connects admin, drivers, and users within a single integrated system. The main objective of the system is to improve bus route planning and driver duty allocation. The system helps manage buses, routes, drivers, and schedules in an organized way and stores data securely in the database. The system provides a dashboard where admin can manage transport data. Drivers can view assigned duties and route details. Users can check bus timing and route information. The system ensures proper planning and improves transport efficiency.

### **1. Modules**

#### **1.1 Admin Module**

In this module, the admin logs into the system securely and manages all transport data. Admin can add bus details, driver information, and route data. Admin can also assign duties to drivers and monitor system performance through dashboard. The admin can view summary such as total buses, total drivers, total routes, and duty allocation details.

#### **1.2 Driver Module**

Drivers can log into the system and view assigned duties. The driver can check route details, bus number, and duty schedule. This module helps drivers understand their work schedule clearly. It also helps avoid confusion in duty assignment.

#### **1.3 User Module**

Users can access bus route and timing information. Users can view available buses, route details, and travel schedule. This module helps passengers get correct information about bus services and reduces waiting time.

#### **1.4 Route Optimization Module**

This module helps in selecting suitable routes for buses. The system checks route distance, travel time, and passenger demand. Based on this data, the system selects best possible route to reduce delay and improve service.

#### **1.5 Duty Allocation Module**

This module assigns duties to drivers automatically. Duty is assigned based on driver availability, route schedule, and working hours. The system ensures proper duty distribution so that workload is balanced among drivers.

### **2. Backend Architecture (.NET and SQL Server Integration)**

The system uses .NET Web API and SQL Server database to manage data storage and communication between frontend and backend.

- Authentication: Ensures secure login for admin, driver, and user.
- Database: Stores data related to buses, drivers, routes, duties, and users.
- API Services: Helps frontend communicate with backend securely.

#### **3. Data Processing and Notification Workflow**

- Admin enters bus, driver, and route details into the system.
- The system processes data and selects suitable routes.
- Duty is assigned to drivers based on schedule and availability.
- Data is stored in the database.



- Users can view bus details and timing.
- Admin can view reports and monitor system performance.

## **VII. IMPLEMENTATION DETAILS**

The system begins with user registration and secure login. Administrators can add and manage data related to buses, drivers, and routes. Drivers can view their assigned duties, while users can access route information. Route optimization is carried out by analyzing different parameters such as distance and traffic conditions. Duty allocation is handled automatically, ensuring that drivers are assigned work in a balanced manner.

### **User Input and Registration**

Users such as passengers and administrators securely log into the application using their credentials. New users must first complete the registration process by providing basic details such as name, email, phone number, and password. After successful login, passengers can search for bus routes by entering the source and destination locations. Administrators also log in through a secure authentication system to manage buses, routes, drivers, and schedules. Proper input validation techniques are applied to maintain data accuracy and system security.

### **AI Route Optimization and Bus Allocation**

When a passenger searches for a route, the AI engine processes the request and finds the most efficient bus route. The AI model considers multiple parameters such as distance, traffic conditions, travel time, number of stops, and historical trip data. The system dynamically adjusts route suggestions when traffic conditions change, ensuring that passengers receive accurate travel information. The optimized results are displayed clearly, allowing users to select and confirm their preferred route easily.

### **Admin Verification and Management**

Administrators play a crucial role in managing and verifying system data. The admin dashboard provides full control over buses, drivers, routes, and schedules. Admin users can add new buses, assign drivers, define routes, and monitor system performance. All booking requests and route details are stored in the database and displayed in the admin panel. Administrators can review booking information, update schedules, and ensure that buses are allocated efficiently. The dashboard also provides analytical reports such as total bookings, total buses, passenger count, and revenue details. These insights help administrators make better decisions and improve overall transport efficiency.

### **Notifications and Real-Time Updates**

The system provides real-time notifications to passengers and administrators regarding booking confirmations, bus schedules, and route updates. Passengers receive instant alerts when their ticket is successfully booked. Real-time GPS tracking allows users to monitor the live location of buses. Estimated Time of Arrival (ETA) is calculated using AI prediction models, helping passengers plan their journey effectively. Administrators receive notifications about new bookings, schedule updates, and system alerts. This ensures quick response and smooth management of transport operations. The notification system improves communication between users and the transport authority, reducing waiting time and improving passenger satisfaction.

### **History and Data Reusability**

The system stores previous booking records, route history, and passenger details for future reference. This historical data is useful for model training and time. Administrators can analyze past data to identify popular routes, peak travel times, and passenger demand patterns. This helps in improving route planning and resource allocation. Passengers can also view their previous bookings, making it easier to repeat travel plans without entering details again. Maintaining historical records ensures continuity, better decision-making, and faster response during high-demand travel periods.



**SYSTEM AECHEITURE**

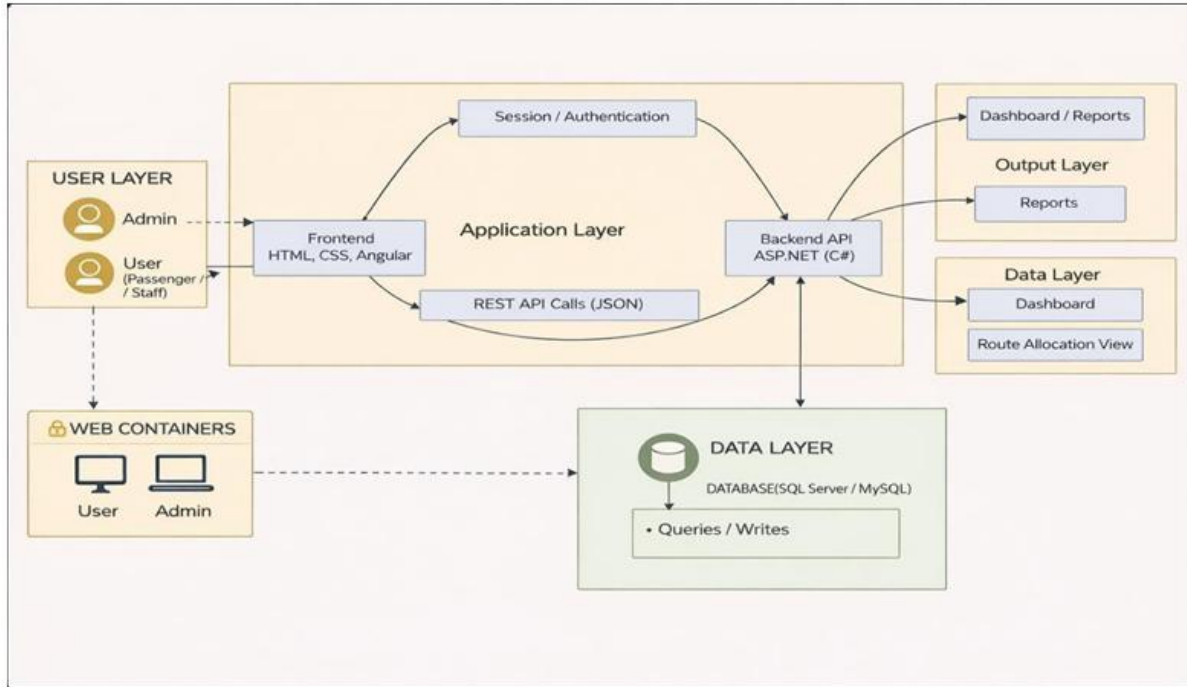


Figure 1: System architecture

**VIII. PROPOSED SYSTEM**

**Step 1: User Registration**

Admin, Drivers, and Users register in the system using their details. Admin can add bus, route, and driver information. Drivers can log in to view their assigned duties.

**Step 2: Login & Authentication**

The system verifies users using secure login authentication. Each user can access the system based on their role such as Admin or Driver.

**Step 3: Bus and Route Data Entry**

Admin enters bus details, route information, source, destination, and schedule. The system stores all route data in the database for further processing.

**Step 4: AI Route Optimization**

The system analyzes route data and selects optimized routes to reduce travel time and improve efficiency. AI helps in identifying better scheduling and route planning.

**Step 5: Duty Allocation**

The system automatically assigns duties to drivers based on route schedule and driver availability. Admin can also update duty assignments if required.

**Step 6: Reports and Dashboard**

The system generates reports such as total buses, drivers, routes, and duty allocation details. Admin can view reports in dashboard for monitoring system performance.



### **IX. ANALYSIS OF PROPOSED SYSTEM**

#### **1. Enhanced Efficiency and Real-Time Management**

The proposed Smart Bus Route Optimization System improves transport efficiency, accuracy, and system reliability. By integrating web technology with a centralized SQL database, the system provides real-time updates for bus routes, driver duties, and schedules. This reduces manual work and improves communication between admin and drivers.

#### **2. Intelligent Route Optimization**

The system analyzes route data such as source, destination, and distance to provide optimized routes. AI-based logic helps reduce travel time and improves fuel efficiency. Optimized route planning helps in better management of transport operations and reduces delays.

#### **3. Secure Role-Based Access**

The system provides role-based login access for Admin and Drivers. Each user can access only authorized features. Admin manages buses, routes, drivers, and duties, while drivers can only view assigned schedules. This ensures data privacy and system security.

#### **4. Improved Coordination and System Reliability**

Compared to manual record systems, the proposed system centralizes all transport data in one database. Admin can easily manage buses, routes, and driver duties from one dashboard. This improves coordination and reduces errors in duty allocation and route planning.

### **MODULES**

The proposed Smart Bus Route Optimization System is divided into five main modules: Admin, Bus, Route, Duty Allocation, and Reports Module. Each module performs specific functions to ensure smooth working of the system.

#### **1. Admin Module**

The Admin Module manages the entire system. Admin can add, update, and delete buses, routes, drivers, and duty details. Admin also monitors system data and ensures proper working of all modules.

#### **2. Bus Module**

The Bus Module stores information about buses such as bus number, capacity, and availability. Admin can manage bus details and ensure proper allocation of buses to routes.

#### **3. Route Module**

The Route Module manages route information including source, destination, and distance. The system uses route data to plan optimized paths and improve transport efficiency.

#### **4. Duty Allocation Module**

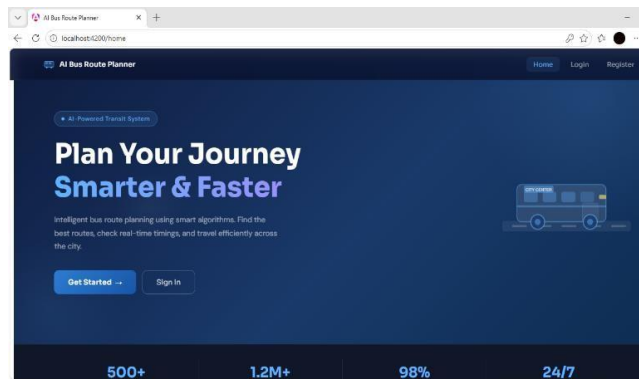
The Duty Allocation Module assigns duties to drivers based on route schedule and driver availability. The system ensures equal distribution of work and maintains duty records for future reference.

#### **5. Reports Module**

The Reports Module generates reports such as total buses, drivers, routes, and duty assignments. Admin can view reports through dashboard for analysis and decision making.



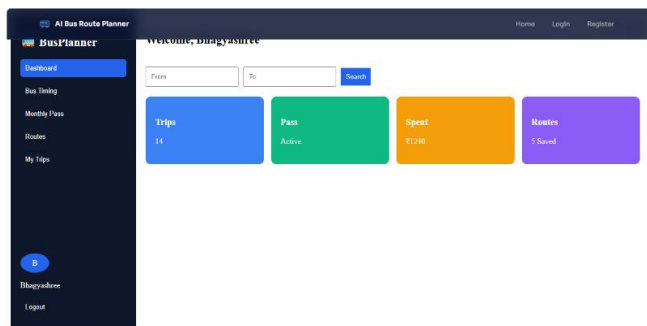
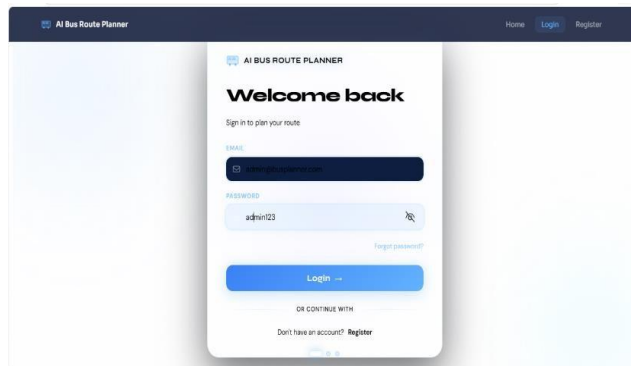
**XI. RESULT**



**HOME & ADMIN LOGINS**



**ADMIN & USER DASHBOARD**



### X. CONCLUSION

The Smart Bus Route Optimization and Duty Allocation System offers a practical solution to common challenges in public transport management. By combining route optimization with automated duty allocation, the system improves efficiency and reduces operational difficulties. It also enhances the experience for passengers by providing reliable and accessible information. With further development, this system can be extended to support larger and more complex transport networks.

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