

SmartYatri: Online Bus Pass Management System

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Abstract : The increasing demand for efficient transportation management in educational institutions has created the need for smart and automated transit systems. Traditional bus pass management methods mainly rely on manual documentation, paper-based verification, and offline payment processes, which often lead to delays, data inconsistency, and reduced operational efficiency. To address these challenges, this paper presents SmartYatri: Online Bus Pass Management System, a web-based platform developed to simplify and digitalize bus ticket and pass management processes. The proposed system provides a centralized solution for students, staff members, conductors, managers, and administrators. Developed using modern web technologies such as Next.js, Prisma, and PostgreSQL, the platform ensures security, scalability, and efficient data management. The system supports online ticket booking, pass purchasing and renewal, travel history tracking, profile management, and notification services through a user-friendly interface. A key feature of SmartYatri is QR code-based verification, which enables conductors to validate tickets and passes quickly and accurately. The system also includes role-based access control, secure payment verification, automated approval workflows, and real-time updates. Additionally, administrative modules help manage routes, buses, fares, users, and reports efficiently.

By reducing paperwork and minimizing manual errors, SmartYatri improves transparency, enhances the commuting experience, and supports smart and sustainable transportation management in schools, colleges, universities, and other organizations.

INDEX TERMS: *SmartYatri, Online Bus Pass Management System, Smart Transportation, QR Code Verification, Role-Based Access Control (RBAC), Ticket Management, Digital Payment Verification, Travel History Tracking, Web-Based Application, Public Transport Automation, Next.js, PostgreSQL, Prisma ORM, Transit Management System, Educational Transportation Services.*

1. INTRODUCTION

Transportation management plays an important role in educational institutions and organizations where a large number of students and staff depend on daily bus services for safe and convenient travel. In many institutions, the existing bus pass management process is still handled manually using paper records, physical verification, and offline payment methods. These traditional approaches are time-consuming, difficult to manage, and often lead to problems such as data redundancy, delayed verification, loss of records, and reduced operational efficiency. As the number of commuters increases, there is a growing need for a smart, secure, and automated transportation management system.

To overcome these limitations, this paper presents **SmartYatri: Online Bus Pass Management System**, a web-based application designed to digitalize and simplify bus ticket and pass management operations. The system provides an integrated platform for students, staff members, conductors, managers, and administrators to manage transportation-related activities efficiently. Users can book tickets, apply for bus passes, renew passes, track travel history, and receive notifications through a simple and user-friendly interface. The proposed system is developed using modern web technologies such as Next.js, Prisma, and PostgreSQL to ensure secure, scalable, and efficient data management. One of the major features of the system is QR code-based verification, which allows conductors to verify tickets and passes quickly and accurately. The system provides an effective and reliable solution for smart transportation management in schools, colleges, universities, and other organizations.

2. LITERATURE REVIEW:

In recent years, transportation management systems have experienced significant improvements through the use of digital technologies, web-based platforms, and automated verification methods aimed at improving operational efficiency and commuter convenience. Several studies have focused on smart transportation systems that support online ticket booking, digital pass generation, and centralized transportation management. Recent research highlights the development of transportation applications that integrate database management, secure authentication, and automated monitoring features to improve the quality of transportation services [1][2][3]. These systems demonstrate the importance of digital transportation management; however, many of them mainly focus on basic booking functionalities rather than providing a complete transportation management solution.

Web-based bus pass and ticket management systems have also gained importance in educational institutions and public transportation services. Researchers have proposed systems that allow users to apply for bus passes online, manage travel records, and reduce manual paperwork through centralized digital platforms [4][5]. These systems improve accessibility, reduce processing time, and simplify administrative tasks. However, several existing applications still lack advanced functionalities such as automated approval workflows, secure role-based access control, and integrated transportation monitoring features.

Security and verification mechanisms have become important research areas in modern transportation applications. Several studies have introduced QR code-based verification systems and secure digital payment processing methods to improve ticket authentication and reduce fraudulent activities [3][6][7]. These technologies help conductors and administrators verify tickets and payment records efficiently. Despite these advancements, many transportation systems still face challenges related to centralized data management, scalability, and integration of multiple transportation services into a unified platform. Recent developments in web technologies and database systems have further enhanced the performance and scalability of transportation applications. Technologies such

as Next.js and PostgreSQL support responsive interfaces, secure data storage, and efficient handling of transportation records [7][8]. Researchers have also emphasized the importance of centralized administration modules for managing routes, buses, fares, users, and travel records systematically. However, many existing systems still focus on individual functionalities such as ticket booking, payment verification, or passenger management without integrating all transportation services into a single centralized platform [8][9].

From these studies, it is clear that although considerable progress has been made in digital transportation systems, many existing applications still lack complete automation, centralized management, and integrated verification mechanisms. Therefore, the proposed project, **SmartYatri: Online Bus Pass Management System**, aims to provide a secure, scalable, and user-friendly transportation platform that integrates online ticket booking, bus pass management, QR code verification, secure payment processing, travel history tracking, role-based access control, and automated administrative functionalities into a single centralized transportation management solution.

3. PROPOSED SYSTEM:

3.1 System description:

The proposed system is **SmartYatri: Online Bus Pass Management System**, a web-based transportation management platform designed to simplify and automate bus ticket and pass management operations for educational institutions and organizations. SmartYatri is developed using modern technologies such as Next.js, Prisma, and PostgreSQL to provide a secure, scalable, and user-friendly digital transportation solution. The system integrates features such as online ticket booking, pass purchasing and renewal, QR code verification, secure payment verification, notification services, and travel history tracking into a single centralized platform. The SmartYatri system is different from traditional transportation management methods that mainly depend on manual documentation, paper-based verification, offline payment collection, and physical record maintenance. Existing manual systems are time-consuming, difficult to manage, and often lead to problems such as data redundancy, delayed approvals, and reduced operational efficiency. In contrast, SmartYatri provides a fully digital and integrated environment that can be accessed through standard web applications without requiring complicated manual procedures or physical verification processes.

3.2 Functional Modules:

1) Online Ticket and Pass Management Module

This module allows students and staff members to book daily bus tickets and purchase or renew bus passes through an online platform. The system manages ticket availability, pass validity, pricing details, and travel records in a centralized database. Users can easily access their active and previous tickets or passes through a user-friendly interface, reducing the need for manual paperwork and physical verification processes.

2) QR Code Verification Module

The QR Code Verification Module is designed to improve the accuracy and speed of ticket and pass validation. Each registered user is provided with a unique QR code linked to their travel and pass details. Conductors can scan the QR code to verify whether the ticket or pass is active and valid for travel. This module helps reduce fraudulent activities, minimizes manual checking errors, and improves the efficiency of transportation management operations.

3) Route and Bus Management Module

This module helps administrators and managers efficiently manage bus routes, buses, stops, and fare structures. The system stores route details, stop information, and bus assignments in a centralized database for easy access and modification. Managers can update route schedules, assign buses to specific routes, and manage transportation pricing through an integrated administrative interface. The module supports efficient transportation planning and reduces operational complexity.

4) Interactive User and Notification Module

The system provides an interactive interface that allows users to access transportation services and receive real-time updates. Students, staff members, conductors, and administrators can view ticket status, pass validity, travel history, and approval updates through dedicated dashboards. The notification system sends alerts regarding ticket approvals, pass expiry, payment verification, and important transportation announcements, thereby improving communication between users and administrators.

5) Centralized Administrative Analytics Dashboard

The Administrative Dashboard acts as a centralized control system for managing transportation operations and monitoring system activities. The dashboard provides information related to user records, payment verification, route management, travel history, ticket and pass approvals, and operational reports in a simplified format. Administrators can efficiently monitor transportation activities, manage user roles and permissions, and generate reports for better decision-making. This module improves transparency, security, and overall system administration efficiency.

6) Role-Based Access Control Module

This module manages system access according to the roles and responsibilities of different users such as students, staff members, conductors, managers, and administrators. Each user is provided with specific permissions to access authorized features only. The implementation of role-based access control improves system security, protects sensitive information, and ensures efficient management of transportation operations.

3.3 System Workflow

The system operates using a client/server architecture to manage transportation services efficiently. The workflow begins when students or staff members access the web-based platform to apply for bus passes, renew passes, or book tickets. Users enter required details such as personal information, route selection, and payment details through the client interface. After submission, the request is sent to the backend server for processing.

The backend validates the user information and forwards the request to the appropriate functional modules. The system processes ticket booking, pass generation, payment verification, and notification services through a centralized database. Role-based access control is implemented to provide secure access to different users such as students, staff members, conductors, managers, and administrators.

The QR code generation module creates a unique QR code for each ticket and bus pass. Conductors scan the QR code to verify the validity of tickets and passes in real time. The administrative modules manage routes, buses, fares, approvals, and user records through secure backend operations. After all data is processed, the system displays the updated information, notifications, and transaction status through user dashboards and administrative interfaces in a simple and user-friendly format.

4 SYSTEM ARCHITECTURE

The SmartYatri System uses a multi-layered and modular architecture to provide secure, scalable, and efficient transportation management services. The system follows a service-oriented architecture that enables clear separation between different functional modules, allowing independent development, simplified maintenance, and easy integration of new features. The architecture of SmartYatri consists of five primary layers: the Frontend Layer, Backend Layer, Authentication and Security Layer, External Service Integration Layer, and Database Layer. Each layer performs specific operations and communicates with other layers through secure interfaces to ensure smooth data flow and efficient system performance.

1. Front End:

The front end provides users with an interactive platform to access transportation services and manage travel-related activities. The system contains different interfaces for various types of users:

- **Student/Staff Interface** – Allows users to apply for bus passes, book tickets, renew passes, view travel history, and receive notifications through a user-friendly dashboard.
- **Conductor Interface** – Enables conductors to scan QR codes and verify the validity of tickets and bus passes in real time.

• **Admin Interface** – Allows administrators and managers to monitor transportation activities, manage routes, verify payments, approve requests, and generate reports.

The frontend layer is responsible for collecting user inputs and displaying processed outputs through responsive and easy-to-use interfaces.

2. Back End:

The backend layer acts as the central processing unit of the SmartYatri system. It is developed using modern server-side technologies and manages communication between the frontend, database, and external services. The backend processes user requests, performs validations, and controls system operations.

The backend provides functionalities such as:
REST API handling, authentication

- REST API handling authentication
- Ticket booking and pass management
- Payment verification and approval workflows
- QR code generation and validation
- Notification and status update handling
- Route, bus, and fare management
- Report generation and administrative operations

The backend serves as the primary communication layer for all transportation-related processes.

3. Algorithmic Levels:

The Algorithmic Levels provide intelligent transportation management and automated processing by integrating secure validation mechanisms with centralized data handling techniques to deliver efficient ticket and bus pass management operations.

Key functionality that this level provides includes:

- QR code generation and validation – to provide secure ticket and pass verification
- Ticket booking and pass allocation processing – to manage transportation requests efficiently
- Travel history tracking and record management – to maintain user travel information
- Payment verification and transaction validation – to ensure secure and reliable payment processing
- Role-based access control verification – to manage user permissions and system security
- Real-time notification synchronization – to provide instant updates regarding bookings, approvals, and pass status

The algorithmic levels improve the system's ability to provide secure, accurate, and efficient transportation management services through automated and data-driven operations.

3. Integrated External Services

The SmartYatri system integrates multiple external services through APIs to improve functionality and provide real-time communication features.

The integrated services include:

- QR Code API – For ticket and pass verification
- Payment Gateway Services – For secure online payment processing
- Email and Notification Services – For sending alerts and status updates
- OTP Authentication Services – For secure user verification
- Cloud Hosting Services – For scalable and reliable system deployment

These services provide updated and secure communication between system components and users.

4. Database Layer

The database layer stores and manages all transportation-related information used by the system. The SmartYatri system uses a centralized database built using PostgreSQL for secure and efficient data management.

The database stores the following information:

- User profile and authentication records
- Ticket booking and bus pass details
- Payment and transaction records
- Route, bus, and fare management data
- Travel history and notification logs
- Administrative reports and operational records

The database layer ensures data consistency, fast retrieval, secure storage, and scalability for future expansion.

5. System Workflow

The SmartYatri system follows a structured workflow for handling user requests and transportation operations. Users interact with the system through the frontend interface to book tickets, apply for passes, renew services, and access transportation information. The backend validates user inputs, processes requests, and communicates with the database and external services when required.

The system generates QR codes for tickets and passes, which are verified by conductors through the conductor interface. Administrative modules manage route details, approvals, fare structures, and reports using secure backend operations. The processed data is retrieved from the database and displayed to users through dashboards and notification systems. The layered architecture ensures smooth communication between all modules and supports efficient, secure, and reliable transportation management operations.

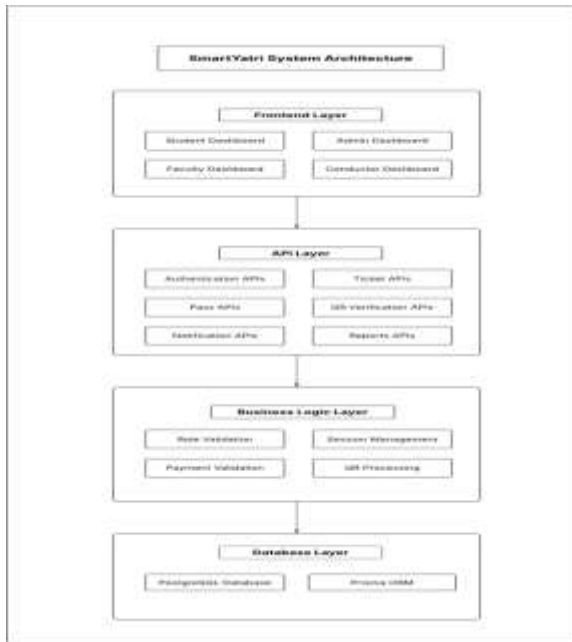


Fig 4.1 System Architecture

4.1 DFD Diagram:

4.1.1 Level 0 DFD:

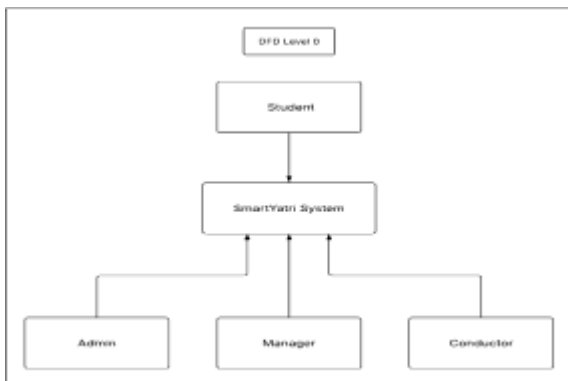


Fig 4.2 Level 0 Data Flow Diagram

The **DFD Level 0 Diagram** shows the basic interaction between users and the **SmartYatri System**. In this diagram, the system acts as a central platform connecting four main users: **Student, Admin, Manager, and Conductor**. Students use the system for ticket booking and bus pass services, admins manage approvals and records, managers handle transportation operations, and conductors verify tickets and passes. The diagram represents the overall flow of information between users and the system.

4.1.2 Level 1 DFD:

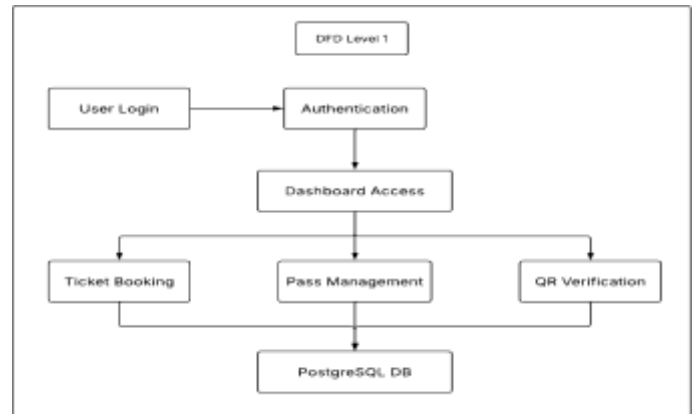


Fig 4.3 Level 1 Data Flow Diagram

The **DFD Level 1 Diagram** represents the internal workflow of the **SmartYatri System**. The process begins with user login and authentication, where the system verifies user credentials before providing dashboard access. After successful authentication, users can access functionalities such as ticket booking, pass management, and QR code verification.

4.1.3 Level 2 DFD:

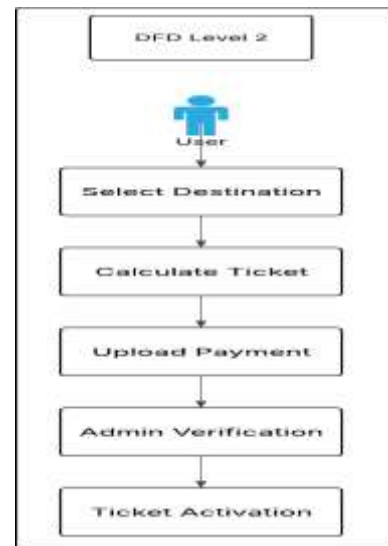


Fig 4.4 Level 2 Data Flow Diagram

The **DFD Level 2 Diagram** explains the detailed ticket booking process in the **SmartYatri System**. The user first selects the travel destination, and the system calculates the ticket fare automatically. After fare calculation, the user uploads the payment details for verification. Finally, the admin verifies the payment, and the ticket is activated successfully.

5 METHODOLOGY

The proposed system is developed as a centralized digital transportation platform that provides online ticket booking, bus pass management, QR code verification, and transportation monitoring services through a single web-based application.

To achieve this, the project follows a modular approach in which each functional component is designed independently and connected through a centralized backend server. The system operates using a client-server architecture where students, staff members, conductors, managers, and administrators interact with the platform through a simple and user-friendly interface. Users can apply for bus passes, book tickets, renew passes, verify payments, and access travel information through the application interface. Once the required information is submitted, the request is forwarded to the backend server for processing and validation.

The ticket booking and pass management modules process user requests by verifying user details, route information, payment records, and pass validity. The QR code verification module generates unique QR codes for tickets and passes, allowing conductors to verify travel authenticity in real time. The system also implements role-based access control to manage user permissions securely and provide authorized access to different functionalities.

To ensure effective transportation management and system security, a centralized administrative monitoring module is included within the platform. The administrative module manages user records, route details, fare structures, payment verification, approval workflows, and transportation reports through secure database operations. In addition, the notification framework acts as the primary communication mechanism of the system by sending real-time updates related to ticket bookings, pass approvals, payment confirmations, and travel notifications. The main objective of the methodology is to provide a secure, scalable, and efficient transportation management system that improves user convenience and reduces manual administrative work.

6 IMPLEMENTATION

The proposed system is implemented as a web-based transportation management application by integrating secure authentication mechanisms, QR code verification, centralized database support, and real-time notification services. The system is designed to provide efficient ticket booking, bus pass management, payment verification, and transportation monitoring functionalities through a single digital platform.

The frontend is developed with a user-friendly interface so that students, staff members, conductors, managers, and administrators can easily access all transportation-related services. The dashboard includes features such as online ticket booking, pass application and renewal, QR code verification, travel history tracking, payment status monitoring, and administrative control functions. The interface is designed to provide smooth navigation and simplified user interaction.

The backend is responsible for handling all user requests and connecting different modules of the system. Whenever a user submits data, the backend processes the request, validates the information, and forwards it to the required module for further operations. The backend also manages authentication, approval workflows, notification services, and role-based access control to ensure secure system functionality.

A centralized database is used to store user records, ticket booking information, pass details, payment transactions, route management data, travel history logs, and administrative reports. This centralized storage improves data consistency, retrieval speed, and overall system performance. The database

is implemented using PostgreSQL to provide secure and scalable data management.

For ticket and pass verification, the QR code module is integrated with the backend server to generate unique QR codes linked with transportation records. Conductors can scan these QR codes to validate ticket and pass authenticity in real time. The payment verification module processes transaction details and approval records before updating the booking or pass status within the system.

The notification and communication framework is implemented to provide real-time alerts regarding ticket confirmations, pass approvals, payment verification, and travel updates. In addition, the administrative management module is connected with the database to monitor routes, buses, fares, user records, and operational reports efficiently.

The complete system is tested using multiple transportation management scenarios to ensure secure performance, accurate verification, efficient data processing, and reliable user interaction across all functional modules.

7 RESULTS AND DISCUSSION

SmartYatri has been evaluated to support efficient digital transportation management for students, staff members, conductors, and administrators. The system contains various modules such as online ticket booking, bus pass management, QR code verification, payment verification, travel history tracking, and centralized administrative monitoring. These modules were evaluated by testing the performance of individual components, analyzing system response time, verification accuracy, database operations, and user interface usability.

The Ticket Booking and Pass Management modules were thoroughly tested using multiple user requests across different transportation routes and travel schedules. The performance of the system was found to be effective in managing ticket reservations, pass renewals, and user verification processes. The system successfully handled user requests through secure validation mechanisms and role-based access control features, ensuring reliable transportation management operations.

The QR Code Verification module was implemented to improve the speed and accuracy of ticket and pass authentication. Unique QR codes generated by the system were successfully scanned and validated through the conductor interface in real time. The verification process reduced manual checking errors and improved the efficiency of transportation monitoring activities. The system also maintained accurate travel records and minimized the possibility of ticket duplication or unauthorized access.

The centralized administrative module was evaluated for managing transportation operations such as route management, fare handling, user approvals, and report generation. The module efficiently processed transportation records and administrative activities through secure backend operations. The notification framework also functioned effectively by sending real-time alerts related to bookings, pass approvals, payment verification, and travel updates.

The complete system was tested under multiple transportation management scenarios to ensure secure performance, efficient database handling, low response time, and reliable user interaction. The results indicate that SmartYatri provides an effective, scalable, and user-friendly transportation management solution that improves operational efficiency, reduces manual work, and enhances the overall commuting experience.

8 FUTURE WORK

The functionality and efficiency of the SmartYatri platform can be further improved through the implementation of advanced technologies and additional transportation management features.

- **GPS-Based Bus Tracking:** Implementing real-time GPS tracking to allow users to monitor live bus locations and estimated arrival times.
- **Cloud-Based Scalability and Backup:** Enhancing the system with cloud storage and automated backup mechanisms to improve scalability, reliability, and secure data recovery.
- **Localization and Multi-Language Support:** Introducing regional language support to improve accessibility and usability for users from different linguistic backgrounds.

9 CONCLUSION

SmartYatri is a web-based transportation management system developed to simplify and automate bus ticket booking and bus pass management processes for educational institutions and organizations. The system successfully provides a centralized platform for students, staff members, conductors, managers, and administrators to manage transportation services efficiently. Features such as online ticket booking, bus pass renewal, QR code verification, payment verification, travel history tracking, and real-time notifications improve the overall transportation experience and reduce manual administrative work. The implementation of secure authentication, role-based access control, and centralized database management enhances system reliability, transparency, and operational efficiency. Although the system may face challenges such as internet dependency and increasing data management requirements, it provides a strong foundation for future smart transportation solutions. With additional advanced features and wider adoption, SmartYatri can become an efficient, scalable, and user-friendly transportation management platform for schools, colleges, universities, and other organizations.

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