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PROJECT PROPOSAL

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PROJECT PROPOSAL

SUBJECT: DATA STRUCTURES

TOPIC: EBR WEBAPP PROJECT PROPOSAL

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Electro Bus Routes App

1. Abstract

The *Electro Bus Routes (EBR) WebApp* aims to revolutionize public transportation in Punjab by providing a unified digital platform for electric bus route navigation and real-time tracking. Despite the growing adoption of e-buses, passengers currently lack access to live route data, predictive arrival times, and optimized travel paths. This project proposes a web-based solution that integrates **Data Structures and Algorithms (DSA)** with **Artificial Intelligence (AI)** to enhance commuter experience and system efficiency. Using **Dijkstra's Algorithm** for shortest path calculation and **machine learning models** (XGBoost) for Estimated Time of Arrival (ETA) prediction, the app ensures intelligent route planning and accurate real-time updates. Built with **Spring Boot**, **FastAPI**, and **Leaflet.js**, the EBR system provides a responsive, interactive map-based interface powered by **Google Maps API** and **WebSocket** communication. The result will be an accessible, scalable, and eco-friendly transportation assistant that promotes the sustainable use of electric public transport across Punjab and beyond.

2. Introduction

In Pakistan, the Punjab government has initiated **Electro Buses** in various districts to promote eco-friendly transportation. However, there is no easy-to-use platform for the **general public to view bus routes, stops, and real-time locations**.

Our proposed project “**Electro Bus Routes App**” aims to develop a **smart route mapping system** that allows users to:

- View nearby bus stations
- Get shortest path from their location to the nearest route
- Track buses in real-time
- Get predictive arrival times using AI/ML models
- Access fare, route, and distance information

This solution will provide **real-time data, smart navigation, and optimized travel planning, ultimately making public transportation more accessible and efficient**.

3. Problem Statement

Despite the launch of electric bus services, **most citizens are unaware of real-time bus availability, routes, and timings**.

- No central route tracking app exists.
- Lack of shortest path guidance for passengers.
- No predictive system to estimate bus arrivals.

This results in **passenger inconvenience, time loss, and underutilization of the e-bus system**.

4. Proposed Solution

We will develop a Web and Mobile-friendly Application that:

1. Shows **interactive maps with all e-bus routes and stops**.
2. **Locates the user** and finds **nearest stations** using Google Maps API.
3. Uses **Graph Algorithms (DSA)** like Dijkstra's Algorithm to compute **shortest path**.
4. Integrates **AI models** to predict bus arrival times based on traffic, distance, and schedule.
5. Updates **bus positions in real-time** using WebSocket connections.
6. Provides **easy UI** with search, filter, and live route display.

5. Objectives

- Provide a **centralized platform** for Punjab's e-bus routes.
- Offer shortest and optimized routes to passengers.
- Use **AI** for prediction and **DSA** for route finding.
- Ensure **real-time** updates.
- Create a user-friendly **responsive web app**.

6. Technology Stack

Component	Technology	Purpose
Backend & Core Logic	Spring Boot (Java), REST API	Handle main app logic, auth, routes, and communication
Frontend	Thymeleaf, Leaflet.js, Bootstrap/Tailwind	Build interactive and responsive UI
Database	MySQL + Hibernate Spatial	Store bus routes, stops, location data
Mapping & Location	Google Maps API, Leaflet.js	Real-time maps, routes, and address lookup
DSA (Path Finding)	JGraphT (Java)	Dijkstra's / A* algorithm for shortest route
AI & Prediction	Python, FastAPI, XGBoost	Predict bus arrival time and traffic delay
Real-Time Communication	WebSocket	Live location updates
Deployment & DevOps	Docker, Git/GitHub	Deployment & version control

7. AI & DSA Integration

❖ DSA Concepts

- Graph Representation (Bus stops as nodes, routes as edges)
- Dijkstra's Algorithm for shortest path
- A algorithm for optimized travel time

❖ AI Concepts

- Machine Learning (XGBoost) for ETA prediction
- Historical data analysis for accurate arrival time
- FastAPI microservice to integrate ML model with Spring Boot backend

8. System Architecture

1. **User Frontend (Browser / Mobile)** → Map UI + Search
2. **Spring Boot Backend** → Core logic, auth, data
3. **MySQL DB** → Geo-data storage
4. **Python FastAPI Service** → AI prediction microservice
5. **WebSocket Server** → Real-time location push
6. **Google Maps API + Leaflet.js** → Location and route visualization

9. Key Features

- Real-time map with electric bus routes
- Nearest bus stop detection
- Shortest path calculation from user to station
- Bus ETA prediction using AI
- Live bus movement display
- Fully responsive UI for mobile & desktop

10. Modules

1. **User Module:** Register/Login, track buses, view routes
2. **Admin Module:** Add/edit routes, manage buses
3. **AI Module:** Predictive analytics and route optimization
4. **Map Module:** Show live map and shortest path
5. **Notification Module:** Real-time updates

11. Tools & Resources

1. **Languages:** Java, Python, JavaScript
2. **Frameworks:** Spring Boot, Thymeleaf, FastAPI
3. **Libraries:** Leaflet.js, JGraphT, XGBoost
4. **Database:** MySQL + Hibernate Spatial
5. **APIs:** Google Maps API
6. **Others:** Docker, Git/GitHub, VS Code / IntelliJ, Postman

12. Expected Outcomes

1. A **functional web application** showing e-bus routes and shortest paths.
2. **AI-powered predictions** for accurate travel planning.
3. **Improved accessibility** for passengers in Punjab.
4. A scalable platform that can be extended to other cities.

13. Future Enhancements

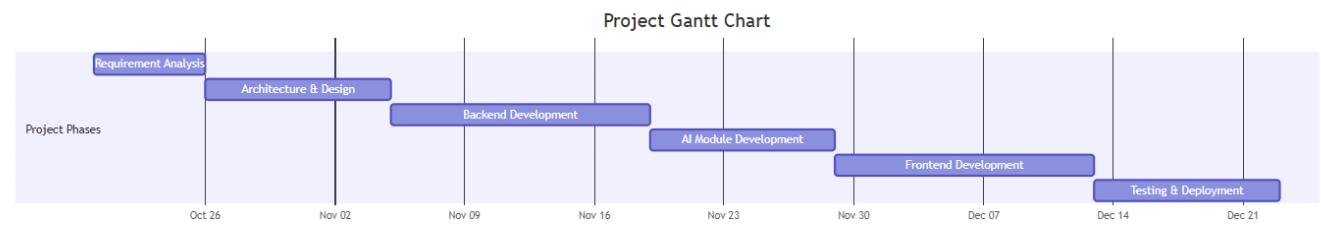
- Integration with live location and arrival time.
- **Mobile app version** (Flutter or React Native).
- Integration with **IoT trackers** on buses.
- Multi-language support (Urdu, English).

14. Team Roles

Role	Responsibility
Backend Developer	Core logic, REST APIs, route calculation
Frontend Developer	UI/UX, map integration
AI/ML Engineer	Prediction models
Database Engineer	MySQL & spatial data management
DevOps Engineer	Deployment, Docker, GitHub

15. Timeline (Estimated)

Phase	Duration	Deliverables
Requirement Analysis	1 week	SRS Document, Project Plan
Architecture & Design	2 weeks	System Design, UI Mockups
Backend Development	3 weeks	APIs, Route Algorithms
AI Module Development	2 weeks	ETA Prediction Integration
Frontend Development	3 weeks	UI + Map Integration
Testing & Deployment	2 weeks	Live App



16. Conclusion

The **Electro Bus Routes App** will bridge the gap between public transport services and citizens by providing real-time information, shortest paths, and smart routing. By combining **AI + DSA** with modern web technologies, this project will be a **powerful, scalable, and practical solution** for the future of public transportation in Pakistan.