**Project Title: Optimizing Bus Rapid Transit (BRT) System Efficiency Using IoT and Predictive Analytics**

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Abstract

This project aims to design and develop a smart management system for Bus Rapid Transit (BRT) networks to enhance their efficiency and reliability in urban environments like Peshawar. Traffic congestion and unpredictable bus arrival times are significant challenges in public transport, leading to passenger dissatisfaction. The proposed solution integrates IoT sensors on buses and at stations to collect real-time data on vehicle location, passenger count, and traffic conditions. This data is processed using predictive analytics and machine learning models to forecast bus arrival times accurately and optimize scheduling. The objectives include creating a web-based dashboard for transit authorities and a mobile application for passengers. Expected outcomes demonstrate reduced waiting times and improved resource allocation for the Zu Peshawar BRT system.

**1. Introduction**

Bus Rapid Transit (BRT) systems are crucial for sustainable urban mobility in developing cities. However, their effectiveness depends heavily on operational efficiency. Research by Ahmed and Qureshi (2022) on BRT systems highlights that inconsistent travel times and lack of real-time information significantly reduce public adoption [1]. In Peshawar, the Zu Peshawar BRT faces similar challenges during peak hours, where unpredictable schedules affect rider satisfaction. While basic GPS tracking exists, it fails to account for dynamic variables like passenger load and traffic patterns. This project addresses these limitations by implementing an IoT and data analytics framework to transform passive tracking into proactive BRT management.

**2. Problem Statement**

Current BRT systems in cities like Peshawar experience operational inefficiencies due to unpredictable schedules, passenger overcrowding at specific stations, and insufficient real-time data for dispatchers. This results in prolonged passenger wait times, inefficient bus distribution, and overall system ineffectiveness. There is a critical need for an intelligent system that not only tracks vehicles but also analyzes data to predict delays and optimize transit operations for better commuter experience.

**3. Objectives**

• To design an IoT-based data acquisition system for collecting real-time bus location, speed, and passenger count data

• To develop a predictive machine learning model for accurate bus arrival time estimation using historical and real-time traffic data

• To create an administrative web dashboard for transit operators to monitor fleet status and manage schedules

• To build a passenger mobile application providing real-time bus locations and arrival predictions

**4. Scope of the Project**

In Scope:

• Cloud-based backend system for data processing and storage

• Simulation of bus movement using Zu Peshawar route data

• Web dashboard and mobile app prototype development

• Software and algorithm development with simulated data

Out of Scope:

• Custom IoT hardware manufacturing and deployment

• City-wide deployment and traffic light integration

• iOS application development (focus on Android and web)

**5. Proposed Methodology**

The solution employs a three-layer architecture:

Data Collection Layer: Simulated IoT sensors (GPS, passenger counters)

Processing Layer: Cloud platform (AWS) with machine learning models (LSTM/Regression)

Application Layer: React.js web dashboard and Flutter mobile app

Tools and Technologies:

• Backend: Python (Django), Node.js

• Machine Learning: Scikit-learn, TensorFlow

• Database: PostgreSQL

• Frontend: React.js, Flutter

• Cloud: AWS EC2, S3, RDS

[Workflow Diagram: IoT Sensors → Cloud API → Database & ML Model → Web Dashboard/Mobile App]

**6. Stakeholders**

Primary: BRT Passengers, Trans Peshawar Operators

Secondary: BRT Administrators, Urban Planners, University Supervisors

**7. Expected Outcomes**

• Functional software prototype with admin dashboard and passenger app

• Validated predictive model with improved arrival time accuracy

• Comprehensive project report and demonstration

• Enhanced public transportation efficiency for Peshawar BRT

**8. References**

*[1] A. R. Ahmed and S. Qureshi, "Evaluating the performance of Bus Rapid Transit systems in developing countries," Journal of Public Transportation, vol. 24, no. 1, 2022.*

*[2] J. G. R. et al., The Internet of Things: Enabling Technologies, Platforms, and Use Cases. CRC Press, 2017.*

*[3] F. Pedregosa et al., "Scikit-learn: Machine Learning in Python," Journal of Machine Learning Research, vol. 12, pp. 2825–2830, 2011.*