

# Telangana AI Rising Grand Challenge

## Optimizing Bus Allocation for Telangana State Road Transport Corporation (TGSRTC)

### Introduction

Telangana State Road Transport Corporation (TGSRTC) operates thousands of buses, serving millions of passengers daily across rural and urban regions. There are however unmet revenue opportunities in all routes due to imbalanced supply and demand. In addition, one of its key initiatives, the Mahalaxmi program, provides free (₹0) tickets for women passengers. The State requires assistance in developing a revenue maximization and seat availability optimization model that accounts for the Mahalaxmi program beneficiaries.

This exercise focuses on optimizing bus allocation for the following two routes:

- Warangal – Uppal (234 Buses)
- Secunderabad – MP (55 Buses)

### Problem Statement

- Underutilized buses on certain routes/times, leading to inefficiencies.
- Overcrowding on high-demand routes and peak hours.
- Unmet revenue opportunities due to imbalanced supply and demand.
- The State wishes to maximize revenue potential and optimize seat availability for the routes, while accounting for Mahalaxmi program beneficiaries.

### Key Objectives

1. **Maximize Revenue**
  - Utilize TGSRTC's pricing data to optimize fare revenue.
  - Allocate buses to routes and times where revenue potential is highest.
2. **Maximize Seat Occupancy**
  - Reduce empty seats by aligning bus deployment with demand.
  - Minimize overcrowding by increasing capacity during peak hours.
3. **Improve Demand Forecasting:** Account for both paid and free riders when planning bus capacity.
4. **Ensure Operational Feasibility**
  - Maintain required service levels for certain routes.

- Ensure allocation does not exceed fleet capacity (including depot-level constraints).

## Proposed Methodology

### 1. Demand Forecasting

- Predict passenger demand (paid + free) per route, time, and day of the week.
- Incorporate historical trends, seasonal variations, and special event data.

### 2. Optimization & Scheduling

- **7-Day Rolling Horizon:**
  - Generate a weekly allocation plan (Day 0–6).
  - Update daily to reflect changes in demand and fleet availability.
- **Optimized Bus Deployment:**
  - Determine the number and type of buses per route/time slot.
  - Provide depot-level allocations if needed.

## Key Insights Expected

- Route viability assessment.
- Identification of critical boarding and alighting points.
- Peak and slack hour passenger patterns.
- Origin-destination analysis for effective operations.
- Detection of high-occupancy and low-occupancy trips.
- Recommendations for operational efficiency improvements.
- Identification of redundant services.

## Constraints & Considerations

1. **Fleet Availability:** Allocation cannot exceed TGSRTC's actual operational capacity, including depot limitations.
2. **Mandatory Service Requirements:** Some routes must maintain a minimum frequency of service.
3. **Capacity Management**
  - Buses have fixed seating capacities.
  - Free Mahalaxmi passengers occupy seats, so total demand (paid + free) must align with available capacity.

## Performance Expectations

1. **Scalability:** The solution must handle hundreds of routes and thousands of daily departures efficiently.
2. **Accuracy**
  - Demand forecasting should outperform basic historical models.
  - The final schedule should minimize empty buses and overcrowding.
3. **Constraint Compliance:** Fleet and mandatory service constraints must be adhered to.
4. **Ease of Use:** TGSRTC staff should be able to interpret, modify, and implement the schedule without excessive complexity.