Delhi Metro Network Optimization

Brief Introduction:-

The Delhi Metro - One of the largest transit systems in India, serves over 6-7 million passengers daily across 390+ km of track moving on 12 colored metro lines map and having 280+ stations. Despite its scale and success, challenges like peak-hour traffics, low suburban station density, and reliance on centralized interchange stations persist.

Objective:-

- Based on the above code framework we have submitted have to identify the pain points of the public using the transport facility and also to optimize Delhi metro network.
- To learn from different global metro systems to implement effective and sustainable improvements.
- Also to enhance last-mile connectivity and station accessibility issues.
- Then to Integrate predictive modeling using machine learning to forecast demand and optimize schedules.

Key Research Papers:-

- "Optimizing Urban Metro Network Using Passenger Flow Data"- ***Transportation Research Part C***
- "AI in Urban Transport: Applications in Metro Systems" – ***Journal of Urban Technology***

Comparison DMRC vs Global Network:-

i) Sanghai Metro - Covers a large **network of 830km** with train **frequency (16 tph)** deals with a daily **ridership of 10-12 million** people values a high-medium coverage density.

ii) Delhi Metro - Covers a medium **network of 390km** with train **frequency (12 tph)** deals with a daily **ridership of 6-7million** people values a medium coverage density (which is less compare to different areas in Delhi).

iii) Singapore MRT - Covers a bit low **network of 230km** with train **frequency (20 tph)** deals with a daily **ridership of 3.5-4.5 million** people values a high coverage density.

Problems Analysis:-

1. In Sub-Urban zones we observe quite **poor last miles infrastructure**.
- Solutions:- Partner with local urban bodies to introduce feeder bus systems and we can also Implement digital maps and app integration for last-mile options.
2. Most of the **overcrowding is seen on Central Route** Interchanges e.g. Kashmiri Gate, Hauz Khas, Rajiv Chowk, Janakpuri.
- Solutions:- Introduce bypass services and express trains skipping congested hubs, we can also take step like as to Construct alternate transfer nodes in peripheral zones to distribute transfer load.
3. **Low average train frequency (as 12 tph**) compared to public demand.
- Solutions:-Deploy AI-based demand prediction models to dynamically scale train frequency.
4. **Imbalanced ridership distribution** - high load on a few routes and less availability somewhere.

- Solutions:- Use clustering algorithms to identify underutilized routes & even Offer targeted fare discounts on low-demand routes to balance load.

- Also emphasizes 2 most important questions like :

1. *How can Delhi Metro adopt effective solutions for suburban access?*
2. *What role can AI play in energy and maintenance cost optimization?*

Proposed Framework for Optimization:-

1. **System Comparison on Global Level** - By having a quantitative comparison among different metro networks globally helps to know about their technological approaches and to sort out many problems which DMRC encounters .
2. **Machine Learning Models** - By Supervised models that helps to predict crowd levels at stations, Unsupervised clustering to identify less/overused corridors areas, on the other side Reinforcement learning to suggest train frequency adjustments.
3. **Simulations and Testing**- Building network based simulations to test scheduled changes then to Conduct agent based modelling for flow patterns of our implementation.
4. **Last mile & Accessibility Plans**- To map the gaps in accessing near outer stations and to propose an E-Mobility feeder networks.