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A METHODOLOGICAL APPROACH TO FLEET SIZE ESTIMATION FOR BUS TRANSPORT NETWORKS

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Accurate fleet size estimation is crucial for ensuring efficient bus operations, optimizing resource allocation, and minimizing service delays. Traditional models often assume fixed headways and fail to account for variations in travel time, layovers, and headway changes throughout the day, leading to inefficient resource allocation. This study presents a comprehensive methodology for estimating the optimal number of buses required to operate a route efficiently, considering variations in travel time, layovers, and changing headways. The proposed methodology integrates key operational parameters, including one-way travel time, layover time, round-trip cycle time, and variable headways. It follows four key steps: calculating the round-trip cycle time, estimating the base fleet requirement, adjusting for changing headways, and determining the final fleet requirement by considering peak demand and transition effects. Two scenarios were analysed, one where headway duration exceeds half the round-trip cycle time, and another with multiple headways within the same duration. A case study on bus route 100 (Panadura-Colombo, Sri Lanka) validates the model. The results show that during the initial 5-minute headway period (5:00 a.m.–6:00 a.m.), 24 buses are required. During the transition to a 3-minute headway (6:00 a.m.–6:35 a.m.), an additional 24 buses are needed due to overlapping services. From 6:35 a.m. onwards, 64 buses are required to maintain the 3-minute frequency. The proposed method enhances estimation accuracy by preventing excessive fleet allocation during off-peak hours while ensuring sufficient service capacity during peak periods. A sensitivity analysis demonstrates the robustness of the model by testing scenarios involving minor disruptions in travel time and headway intervals. Furthermore, the study acknowledges the limitations of focusing solely on service frequency, suggesting the integration of passenger demand data in future enhancements. Although the current analysis is based on a single route, the methodology is scalable to multi-route and interconnected networks. This study contributes to transit planning by offering a structured, adaptable approach for optimizing fleet sizes in variable-demand conditions. Future research could explore real-time data integration and advanced optimization techniques to enhance fleet estimation accuracy.

Keywords: Bus transport networks, Fleet size estimation, Headway variation, Operational efficiency, Public transit planning

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