Abstract ID 475

# OPTIMIZING PUBLIC TRANSPORT WITH REAL-TIME PASSENGER ANALYTICS

João Cravo[(1)], Matilde Pato[(1)], José Simão[(1)], Nuno Cota[(2)]

[(1)]Instituto Superior de Engenharia de Lisboa - ISEL
[(2)]SOLVIT – Innovation on Telecommunications

*A46109@alunos.isel.pt, matilde.pato@isel.pt, jose.simao@isel.pt, nunocota@solvit.pt*

**Keywords:** Multimodal transport optimization, Passenger flow analysis, Machine learning, Demand forecasting, Real-time monitoring

**Summary:** Public transport plays a vital role in urban mobility by providing efficient, and accessible transportation while minimizing congestion and pollutant emissions. With this goal in mind, this project contributes to SDG 11, one of the seventeen United Nations Sustainable Development Goals (SDGs), which aims to make cities and human settlements inclusive, safe, resilient, and sustainable. This research presents a data-driven optimization framework for multimodal public transport systems, built upon a prototype system that manages Automatic Passenger Counting (APC) sensor data. The framework aims to improve demand forecasting accuracy, operational strategies, and service optimization by focusing on analysing passenger flow data from APC sensors installed in buses (Maia Transportes and Carris) and at the Ermesinde Railway Station. Through APC systems and data analytics, it enables near real-time monitoring and trend analysis of passenger movements across the network. The system tracks bi-directional passenger counts at each stop with accuracy above 90%, providing insights on boarding and alighting patterns throughout daily operations. The data collection integrates external variables, including weather conditions, traffic patterns, event schedules, and distinctions between school and non-school periods in Portugal, which influence user demand. These external variables will be incorporated into the original data to create a comprehensive understanding of the factors influencing transport demand. As bus operators design their routes to minimize costs, such as reducing congestion and avoiding the duplication of resource allocation, an efficient multimodal strategy becomes essential to optimize these resources. Through statistical modelling and machine learning techniques, the system identifies correlations between these contextual variables and passenger flow variations, generating valuable insights for both immediate operational decisions and long-term planning. This data-driven approach supports evidence-based decisions on resource allocation, schedule optimization, and capacity management across the transport network.

Conducted in partnership with Maia Transportes and Carris, the research leverages proprietary operational data from their transport network to validate and refine the analytical models for practical implementation. The methodology uses machine learning algorithms to identify operational inefficiencies, optimize resource allocation, and implement dynamic scheduling adjustments that respond to real-time fluctuations in passenger demand. The integration of regression models and time-series analysis enables the system to capture both immediate variations and longer-term passenger behaviour patterns, providing a comprehensive foundation for operational decision-making.

Preliminary results show that the integration of external variables with multimodal passenger data significantly enhances flow tracking and demand estimations, leading to better operational efficiency. The research contributes to sustainable urban mobility through three key outcomes: (1) supporting evidence-based multimodal transport planning; (2) increasing public transport system adaptability with real-time and historical data analysis; and (3) providing a prototype system for managing APC sensor data that effectively monitors passenger flows.