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PLANNING COMPETITIVE TRANSPORTATION NETWORKS AS HSR IS INTRODUCED

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Summary: High-speed rail (HSR) plays a major role in the European Union's (EU) push for greener transportation. Policies such as the European Green Deal aim to reduce transport emissions and phase out short-haul flights when rail alternatives exist. The construction of the Lisbon-Porto high-speed line and the planned Lisbon-Madrid connection promise to be a sustainable alternative to the existing travel options. However, understanding how HSR will compete with other transportation modes and optimizing its offer remains challenging.

Existing demand prediction and optimization models have addressed multimodal networks. Nevertheless, their analyses often focus on a single mode or operator, limiting their ability to assess the interactions and competition across the network. In the Lisbon-Porto and Lisbon-Madrid corridors, little is known about how HSR will compete with other modes or affect airport operations. This research develops a model to analyze these interactions, optimize route scheduling and fleet allocation, and support sustainable decision-making.

The methodology integrates a demand model into an optimization model to design multimodal transportation networks. The optimization model, formulated as a mixed-integer linear programming (MILP) problem, focuses on minimizing the operational, social, and environmental costs of three operators: an airline, a high-speed rail operator, and a conventional rail operator. The demand model also accounts for bus services, private transport, and the no-travel option, providing a broader representation of passenger choices and competition between modes.

The transportation network consists of pre-defined cities, origin-destination pairs (markets), a discretized time window, and all possible transportation services each mode offers. These services differ in their departure times and the cities they connect. The demand model allocates the potential demand for each market to the possible itineraries. An itinerary is a sequential combination of transportation services within a specific time window.

Discrete Choice Models estimate the utility of each itinerary using factors such as travel time, price, and passenger references for direct or connecting routes. Based on the demand allocation and cost minimization goals, the optimization model removes services that do not meet a pre-set minimum occupancy rate while maintaining operational feasibility.

The model proposed in this study aims to predict passenger and airline behavior upon HSR's introduction, optimize the demand allocation and availability of HSR services, and identify under-utilized services. In addition, the model seeks to reveal the potential for releasing airport slots occupied by short-haul flights, promoting a more efficient use of airport resources.

This work will provide a solid basis for planning sustainable multimodal transport networks, highlighting the role of HSR in promoting a more efficient and environmentally responsible network.