

Design of a Multi-Modal Transit integrating Dial-A-Ride and Fixed Routes

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Fixed-Route Public Transport (FRPT) is critical for the mobility of urban conurbations. However, it is inherently unsuitable for suburban areas, where the demand density is low and, due to cost constraints, the service has a low frequency and limited coverage. This results in poor Quality of Service (QoS). On the other hand, the Dial-A-Ride (DAR), e.g., Uber,..., services have emerged but, due to their low capacity, they are unsuitable for high-density areas, where they would exacerbate congestion. While DAR operations and FRPT design have mostly been studied separately, the goal of this research is to develop a methodology for the design of "Multi-Modal Transit" (MMT). MMT integrates both FRPT and DAR, to improve QoS in particular in suburban areas, without substantially increasing the operational cost. We formulate the design of MMT as a bilevel problem. In the upper level, we decide on the FRPT lines and their frequencies, as well as the fleet size to allocate to FRPT and DAR. We do so using a Binary Particle Swarm Optimization (BPSO) metaheuristic. The lower level consists of an Integrated Dial-A-Ride problem (IDARP) to construct the multi-modal trips of customers (including FRPT and DAR legs) and the routes of the DAR vehicles, using a Large Neighborhood Search (LNS) metaheuristic. Results show that MMT improves passenger mobility over current urban transportation, in particular in suburban areas, without substantially increasing the operational cost.