Designing a hybrid urban mobility system: framework and bi-level model

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Although traditional public transportation, known as a fixed-route transit (FRT) system, is a cost-efficient transit mode in areas with high demand, it is often perceived as inconvenient due to the lack of flexibility. On the other hand, demand-responsive transit (DRT) systems, known as a flex-route transit system (e.g. dial-a-ride services), have a high per-capita operating cost due to their personalized nature. To combine the flexibility of DRT with the cost-efficiency of FRT, the development of a hybrid transit system could be considered a solution. This research focuses on such a hybrid systems that integrate FRT and DRT systems, leveraging the advantages of both. In this research, first, a unifying framework that classifies different models of FRT and DRT integration is presented. Second, a bi-level optimization approach is proposed to model the design of a hybrid transit system in which users may travel through a combination of FRT and DRT. At the upper level, decisions are made on the FRT lines to be included in the network and their frequencies. For a proposed FRT network structure, the possible sequences of travel modes for all users can be identified. At the lower level, for a subset of requests corresponding to users who cannot complete their trips solely by FRT, the routing and scheduling of DRT vehicles and the fleet size are optimized. Preliminary results of a heuristic solution strategy for this model will be presented.