Simulation-Based Comparison of On-Demand and Line-Based Public Transport Services

Master‘s Thesis of Luis Felipe Gonzalez Andrade

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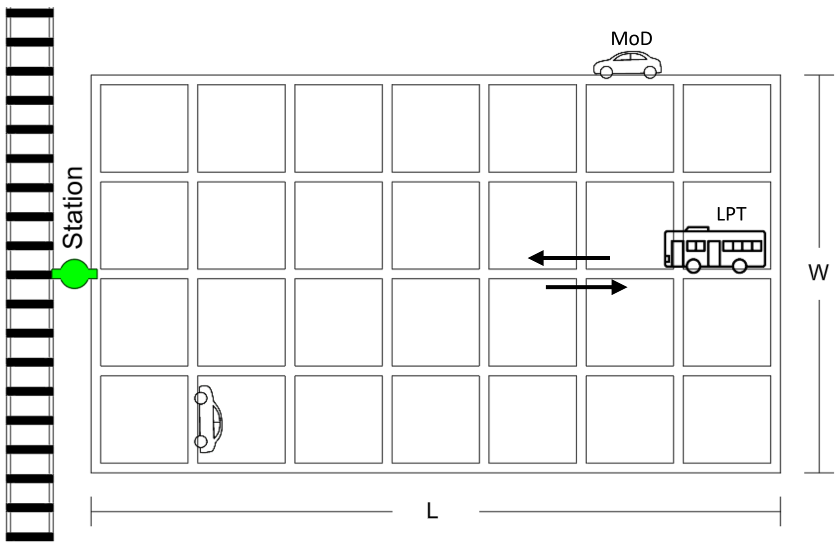

Figure 1: Network model

Emerging demand-responsive mobility approaches have the potential of improving current transit systems by substituting standard public transport services, whose pre-define routes and schedules entail adaptability inefficiencies when they face constant demand fluctuations. This master’s thesis seeks to study the performance of Mobility on Demand (MoD) and Line-based public transport (LPT) services and analyze how they compete against each other. The main objective is to conduct a comparison between these two services by assessing different indicators under predefined conditions. To this end, the simulation software SUMO and Fleetpy are employed to evaluate specific scenarios on LPT and MoD, respectively. Finally, a regression analysis is performed to explore the stochastic nature of MoD operations.

The two services are modelled separately in a feeder system, in which they transport users from the service area to the station (connection to a rail system) and vice versa (*Figure 1*).

Three type of users are modelled: egress (ending at the service area), access (ending at the station), and internal users (accounting for 5% of the total trips). Egress users are generated in batches according to the rail line arrivals. Furthermore, three different egress/access ratios (of the remaining trips) are analyzed: 20/80, 50/50, and 80/20.

Fleetpy uses an object function in which MoD trips are constructed. Two types of pick-up policies are studied: Door-to-door (no walking), and station-based (users must perform a walk as part of their trips)

This thesis studies indicators from the point of view of users: global journey time or GJT (and its components: walking, waiting, and riding time), and served demand; and operator: vehicle kilometers travelled, and occupancy. The final indicator, system cost, encompasses the previously mentioned metrics and gives an insight into the service quality in terms of monetary value.

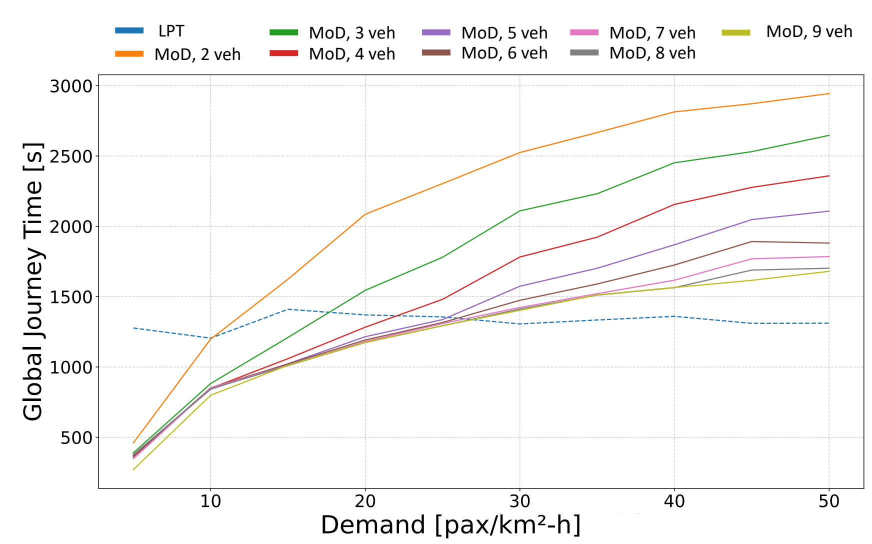

Figure 2: Global journey time for various fleet sizes

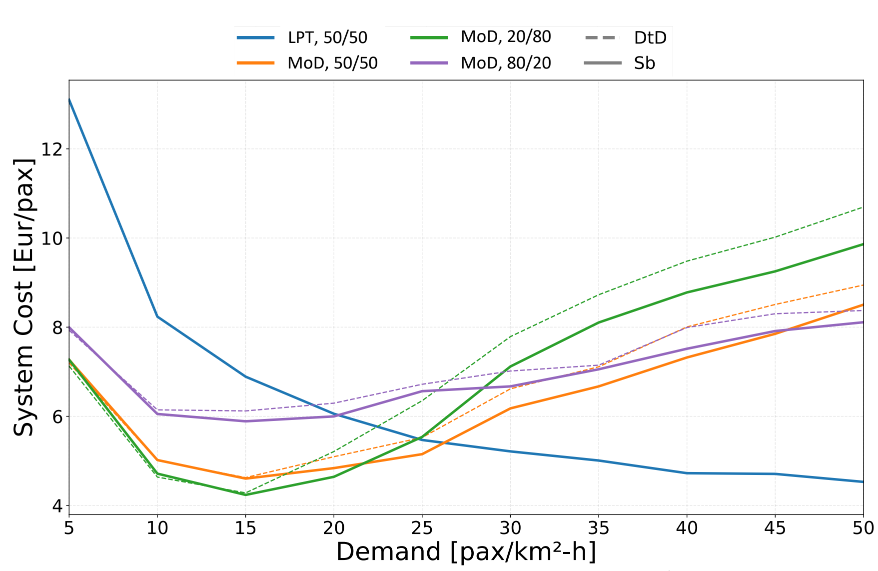

Figure 3: System cost for various policies and egress/access ratios

The simulation results show that GJT of users traveling by LPT is not affected by demand variations. On the contrary, the higher the demand, the longer the travel times by MoD (*Figure 2*). At the same time, a reduction in GJT might be achieved by incrementing fleet size, yet this reduction is only noticeable under high demand densities. As illustrated in *Figure 3*, MoD exhibits a lower system cost than LPT under demand densities below 26 pax/km^2-h. Then, LPT becomes more efficient (i.e., preferable) as demand increases. The point at which LPT curve intersects one of MoD is defined as critical demand and describes the conditions at which the two services might be considered equivalent, and a switch might be desirable. Regarding the two pick-up policies, MoD always improves its service when operated under station-based policy. This improvement, however, becomes noticeable only as demand grows. Looking at the different egress/access ratios, a value of λ=20 generates interestingly equal or even lower cost in comparison to an even egress/access distribution for low demand.