Technische Universität München
Chair of Transportation Systems Engineering

Master's Thesis Topic

Demand-responsive transport in suburban areas: Investigating accessibility and social effects

Background

Public transport is often regarded as the backbone of urban mobility systems. However, lower travel density and sparse network coverage usually hinder its effectiveness in suburban areas. Many researchers and practitioners believe that demand-responsive (shared, autonomous, dial-a-ride, etc.) feeder services could improve some of the first and last-mile deficiencies and ultimately increase the effectiveness of public transport in suburban areas, thus reducing car use and easing congestion. For example, Munich is Germany's congestion capital despite having the lowest car ownership in Bavaria (353 cars per 1000 residents)[1]. On the other hand, car ownership in the surrounding areas is high (e.g. 686 cars per 1000 residents in Landkreis München), thus leading to the conclusion that road traffic in Munich is "imported" from the surrounding areas rather than generated within the city.

The goal of this master thesis will be to explore the effectiveness of a demand-responsive transport (DRT) service as a feeder to public transport lines. The master's thesis student is expected to develop, implement and analyse DRT operational concepts and focus on their implications on accessibility concerning different sociodemographic groups. The objective of this master's thesis can be summarised in the research question: "Does a feeder DRT system improve transport accessibility in suburban areas and for whom?"

Methodology

The following points summarise the expected methodology. Deviations from the project description and new ideas are welcome.

1. Analyse the existing literature on (autonomous) shared DRT as a feeder mode in suburban areas. Focus on accessibility, monetary and temporal gains, and social equity aspects.
2. Analyse the existing travel demand and supply (e.g. public transport network coverage) of a pre-defined study area and the potential for introducing a demand-responsive service.
3. Develop an agent-based simulation framework in MATSim that considers the existing modes (car, public transport, bike, walk) and introduces a DRT service.
4. Develop, implement and simulate different operational and pricing concepts of DRT as a public transport feeder.

[1] Merkur.de: https://www.merkur.de/lokales/muenchen-lk/unterhaching-ort29619/landkreis-buerger-kaufen-weniger-autos-90957237.html

5. Based on the simulation results, estimate the market potential of DRT, its synergical benefits for public transport ridership and analyse the gains in accessibility in suburban areas.

The student is advised to utilise the Munich synthetic population and plans from the TUM Professorship of Travel Behaviour as a case study (Moeckel et al., 2020).

Results

This master thesis will result in a complete agent-based simulation framework incorporating DRT and focusing on suburban areas. Preferably, the methodological framework will be applied to a model for the Munich Metropolitan Region. The main objective will be to estimate the changes in accessibility and assess the social (dis)advantages resulting from this transportation system. The thesis results should help understand how the DRT feeder can influence greater public transport ridership as well.

Key skills

- Completed the "Applied Transport Modelling with MATSim" course at TUM or similar**.** Experience in agent-based modelling is **necessary** for this master's thesis project.
- Completed the "Object-Oriented Programming for Transport Engineers" course at TUM or has previous experience with Java (recommended). Programming skills in R or Python are strongly **recommended**.
- Fluency in English and good scientific skills will be highly **appreciated**.

References and relevant work

Diepolder, S. (2023). On the Computation of Accessibility Provided by Dynamic Transportation Modes. https://mediatum.ub.tum.de/doc/1703119/document.pdf

Moeckel, R., Kuehnel, N., Llorca, C., Moreno, A. T., & Rayaprolu, H. (2020). Agent-Based Simulation to Improve Policy Sensitivity of Trip-Based Models. *Journal of Advanced Transportation, 2020*.

Narayanan, S., Chaniotakis, E., & Antoniou, C. (2020). Shared autonomous vehicle services: A comprehensive review. *Transportation Research Part C: Emerging Technologies, 111*, 255-293.

Peer, S., Müller, J., Naqvi, A., & Straub, M. (2024). Introducing shared, electric, autonomous vehicles (SAEVs) in sub-urban zones: Simulating the case of Vienna. *Transport Policy, 147*, 232-243.

Thao, V. T., Imhof, S., & von Arx, W. (2023). Demand responsive transport: New insights from peri-urban experiences. Travel Behaviour and Society, 31, 141-150.

Starting date

As soon as possible from April 2024 onwards. The thesis will be registered at the Chair of Transportation Systems Engineering (Prof. Antoniou).

How to apply:

Interested applicants should contact Filippos Adamidis (filippos.adamidis@tum.de) and Arkadiusz Drabicki (arkadiusz.drabicki@tum.de) by email. Please include (1) a short explanation (max. 100 words) of why you are interested in this project, (2) a recent transcript of records and (3) any work related to MATSim (e.g. report, paper, Git).