Technische Universität München
Chair of Transportation Systems Engineering

Master's Thesis Topic

Agent-based modelling of passenger overcrowding effects in public transport projects

Background

Public transport (PT) system expansion is essential for ensuring high passenger transportation capabilities of urban mobility networks. Since PT projects are often very capital-intensive, their eventual development hinges on the cost-benefit analysis' outcomes. However, this strategic assessment does not often account for potential impacts of PT capacity constraints - i.e., passenger overcrowding effects of rising travel discomfort, service variability or denied boardings. Models that do not capture such effects may severely over/underestimate the eventual effectiveness of a new PT investment scheme, especially when comparing PT modes of different capacity (e.g. bus vs. rail).

source: merkur.de

Thesis objective

The aim of this master thesis can be summarised by the following research question:

> *"How does the inclusion of capacity constraints' (and passenger overcrowding) effects influence the effectiveness assessment of public transport projects?"*

The master thesis student shall apply agent-based simulation model to analyse the effects of a new urban public transport (PT) connection (e.g. new S-/U-Bahn line vs. existing bus lines) in terms of forecast passenger flows, journey parameters and ultimate cost-benefit analysis - with vs. without including the PT capacity constraints' effects in simulation algorithm.

Methodology

Main points of the expected methodology are summarised below. Reasonable deviations from the project description and new ideas are welcome.

1. Choose and prepare the agent-based simulation model (describing the case study of urban PT corridor or network), adequate for analysing the effects of passenger overcrowding (path discomfort and capacity limits) in route assignment.
2. Formulate modelling scenarios, perform simulations and sensitivity analyses. Process and interpret simulation results, and subsequently use them for cost-benefit assessment of the above stated research problem.

Expected results

Main outcome of this master thesis will be the (simulation-based) assessment of passenger overcrowding effects for expanding urban PT networks. Findings from this thesis will demonstrate how agent-based models can expose the wider ramifications of increased PT system capacity (both from passengers' and operators' perspectives) and underpin the importance of specific overcrowding effects for the ultimate cost-benefit evaluation.

Key skills

- Completed the "Applied Transport Modelling with MATSim" course at TUM or similar**.** Experience in agent-based modelling (MATSim, BusMezzo or similar) is **necessary** for this master's thesis project.
- Fluency in English and good scientific skills will be highly **appreciated**.
- Experience and knowledge of data processing in Python (or similar) is **welcome**.

References and relevant work

Cats, O., & Hartl, M. (2016). *Modelling public transport on-board congestion: comparing schedule-based and agent-based assignment approaches and their implications.* Journal of Advanced Transportation, 50(6), 1209-1224.

Cats, O., West, J., & Eliasson, J. (2016). *A dynamic stochastic model for evaluating congestion and crowding effects in transit systems*. Transportation Research Part B: Methodological, 89, 43-57.

Drabicki, A., Ściga, S., & Chwastek, K. (2023). *Public transport effectiveness evaluation with capacity-constrained macroscopic assignment*. In 2023 8th International Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS) (pp. 1-6). IEEE.

Leurent, F. (2011). *Transport capacity constraints on the mass transit system: a systemic analysis*. European Transport Research Review, 3, 11-21.

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, 1-13.

Van Oort, N., Drost, M., Brands, T., & Yap, M. (2015*). Data-driven public transport ridership prediction approach including comfort aspects*. In 13th CASPT Conference. Available at: http://www.rotterdam2015.caspt.org/proceedings/paper46.pdf

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 Arkadiusz Drabicki (arkadiusz.drabicki@tum.de) and Filippos Adamidis (filippos.adamidis@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 MATSim or similar agent-based simulation modelling, (e.g. report, paper, Git).