Agent-based modelling of the complete commercial traffic: A case study for the Ruhr metropolitan area

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Abstract

This paper introduces an agent-based simulation model that captures the full spectrum of commercial transport in the Ruhr region, including both long-haul freight and the small-scale commercial traffic. By integrating detailed, data-driven modules into an extended person-based framework within the open-source MATSim environment, the model effectively replicates the complex dynamics of economic freight movements and commercial-related trips. This comprehensive approach not only advances simulation realism but also offers valuable insights for optimizing regional transport planning and policymaking.

Keywords Freight Transport, small-scale commercial traffic, Traffic Simulation, MATSim, Logistics, Demand Modeling

1 Motivation and research objectives

This research project aims to develop a comprehensive transportation model that encompasses all commercial traffic segments. Afterward, the existing person model was expanded to include commercial transport, enhancing its realism and applicability. The goal is to provide a traffic model that contains all relevant transport segments, enabling a more holistic understanding of a research area, because most of the existing models focus on passenger transport.

2 Methodology

The presented approach is created as a sum of different modules to create the demand of the different transport segments of the commercial transport Figure 1. The main different commercial segments are the long-distance freight transport and the more local small-scale commercial transport, which includes both passenger-related business trips and local freight movements.

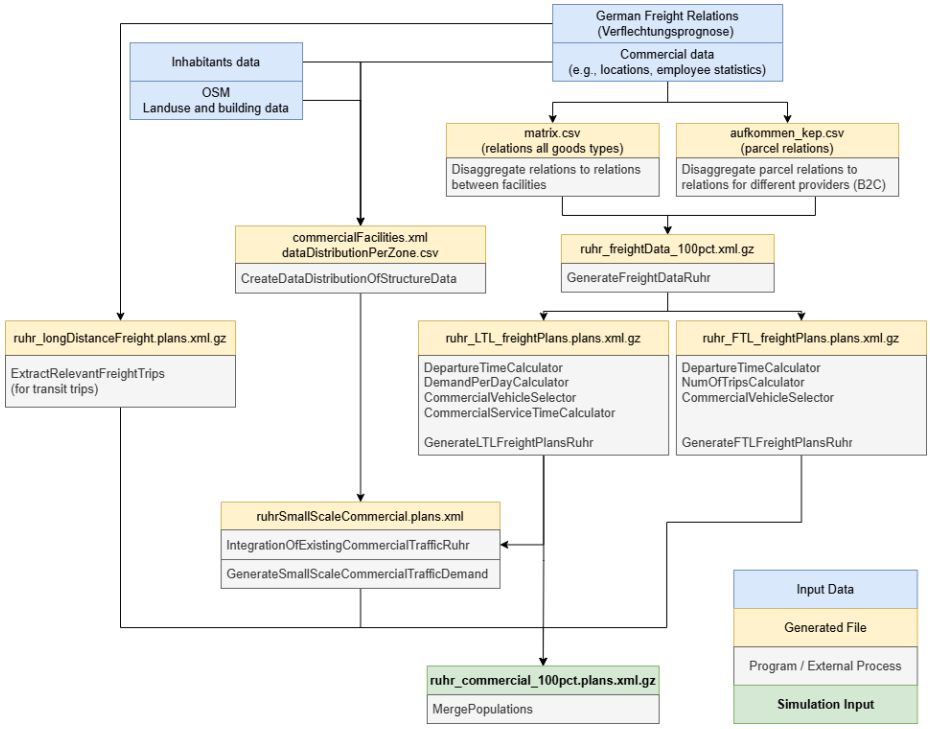

Figure 1: Overview of the implemented workflow for the generation of the commercial transport demand.

Long-distance freight transport relies on data from the [1]. This contains relations of goods between NUTS zones ending, starting, or passing through Germany. In this data, the relations are differentiated by the types of goods and the mode of transport. A basic approach to modeling the long-distance freight transport was created by [2]. Within this approach, we tried to improve the creating of freight tours related to the given data. Therefore, we defined typical tours for the different types of goods. The result is a differentiation between goods handled with full truck loads (FTL) and goods handled with less than truck loads (LTL). For the FTL goods, we defined a tour for each relation, while for the LTL goods, we created a vehicle routing problem (VRP) to create a set of tours. Additionally, we improved the assignment of goods to plausible facilities. In the current state, the model includes all parts of the long-distance freight transport handled by trucks. For relations of combined transport, we include only the truck part of the transport.

The second part of the model is the small-scale commercial transport. The generation is described in [3]and was presented at the MATSim User Meeting 2023.

The implementation was carried out using MATSim, an open-source simulation framework [4, 5]. The source code and input data are publicly available on GitHub[1], ensuring transparency and accessibility for further research and practical applications.

In general, the model is designed to be modular and extensible, allowing for the integration of additional transport segments and the refinement of existing ones. It also includes functionalities to

[1](https://github.com/matsim-scenarios/matsim-metropole-ruhr)

replace demand of the small-scale commercial transport with this more microscopic demand of the commercial transport.

3 Outlook

The developed freight transport model forms a crucial part of the Ruhr Metropolitan Region's overall traffic model. The next step is to generalize the created approach, so that it can be applied to all other MATSim scenarios. Because the data used for the Ruhr region is more detailed than the data available for other regions, the model is not directly applicable to other regions. Therefore, we will generalize the approach to make it applicable to other regions. Future efforts will focus on calibration and validation to enhance predictive accuracy. Additionally, further integration with urban mobility models will improve the holistic understanding of regional transport dynamics.

4 Conclusion

The expansion of the Ruhr traffic model to include freight transport represents a significant step toward a comprehensive simulation framework. By incorporating detailed economic transport segments, the model contributes to more informed infrastructure planning and policymaking in the Ruhr region.

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