

State of the Art Transportation Modeling and Environment Calculation

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Abstract Why do we need models?
The main objective of transport modeling is to support transportation planning processes. The quality of impact studies is increased with the help of models during the planning process. One aspect of modeling objectives focuses on the reduction of operating and maintenance costs for transport service providers. Both, revenues as well as service quality can be improved with the help of modeling.
The introduction of cost-benefit analysis systems results in increased efficiency. This kind of analysis should be based on calculations with actual models based on current data. In case of EU finance investments, it is absolutely mandatory to provide the evidence for an infrastructure project's usefulness before its implementation. This is of particular importance if independent administrative organizations participate in joint tenders. Furthermore, impact studies based on generally accepted models are recognized in legally contentious cases.
The results of studies can be presented by professionals to politicians, decision-makers and the public in a clearly visualized format.

1. What kind of tools exist?

Current modeling methodologies require modern computer-aided modeling with the help of generally accepted specialized modeling software. Regardless of what software the administration is using, it must be based on regularly updated database records. The databases should be maintained with GIS software and advanced transportation planning software. Socioeconomic data (e.g. population, employment, travel demand indicators, etc.) should be recorded for modeling purposes in addition to network data. This data should be available as best as possible corresponding to the desired level of zone detail. Modeling is based on network elements. Modern modeling tools manage private and public transportation elements in one integrated system. These network elements include inter alia the railways, roads, junctions, crossings, public transportation lines, timetables, stops, etc.

Transport modeling software can be divided into three categories:

- Macroscopic
Administration of network elements, building of strategic forecast models, static system
- Mesoscopic
medium-size projects, dynamic system
- Microscopic modeling system
Junctions and small-size project simulation, 3D-vizualization, dynamic system

2. What kind of methodology will be used?

The construction of a network model is the most important part of the model development process. If the administrative does not maintain its own digital network the model can be constructed with digital navigation networks (e.g., TeleAtlas, NAVTEQ). Timetables, public transport lines can be imported from open sources or from digital databases (e.g., Microbus from IVU or Google Transit) provided by public transport authorities.

2.1. Modeling on macroscopic level

The most widely used method to build transport models in the world is called 4-step-modeling and consists of:

- Trip generation
- Trip distribution
- Modal split
- Assignment

The next stage of the modeling process should be the calibration of modeled traffic volume results with measured traffic count data, where available.

In the past, calculations were made on paper. Today, because of the complexity and the amount of statistical data, calculations are being done solely with the help of specialized modeling software such as VISUM by PTV AG.

Model results include important details for private transport such as link and turning movement volume, delay, travel time and level of service (LOS).

Modeling results for public transport contain operational indicators such as performance, travel time management, vehicle use as well as passenger flow indicators such as number of passenger boarding and alighting, seat occupancy, stop accessibility as well as service cost-benefit analysis.

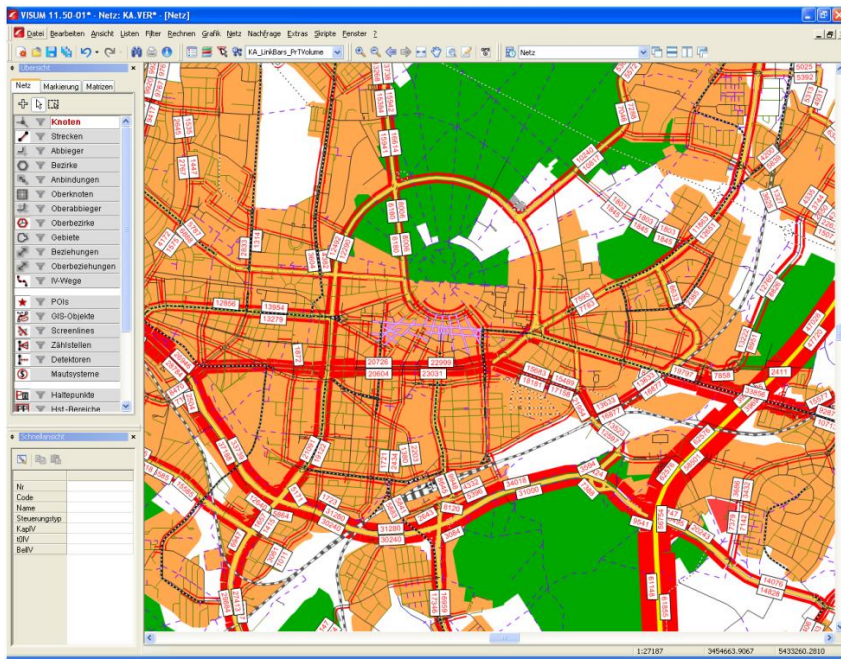


Figure 7. Screenshot of network model in VISUM macroscopic strategic planning tool

2.2. Modeling on mesoscopic and microscopic level

It is difficult to draw a clear dividing line between microscopic and mesoscopic systems. A microscopic simulation of medium-sized networks is extremely time consuming. In some cases, it can take up to several days (or weeks) to run the simulation. However, detailed systems evaluation requires dynamic traffic flow modeling. Therefore, mesoscopic models (e.g. Mezzo from KTH) are recommended for such cases.

In most cases, traffic flow will be simulated with microscopic simulation software such as VISSIM from PTV AG. This system can be used to simulate individual vehicles as they interact with the roadway infrastructure, traffic control and other vehicles. Modern transport modeling systems integrate public transport and private transport in one model which allows the creation of partial networks. Each modeled entity exhibits different kind of properties such as speed, acceleration, size, etc.

Micro simulation systems are an essential tool for transportation planning today. Foremost, it is absolutely necessary to use microscopic simulation systems for impact or capacity analysis of networks for which no standard analytical methods exist. This includes multi junction traffic signal systems, networks with combined roundabouts and traffic signals or highway ramps with high levels of volume fluctuation. Further use cases are traffic signals with actuated signal control or public transport priority.



Figure 2. Screenshot of network model in VISSIM microscopic simulation tool

Pedestrian simulation is a separate, specialized field of microscopic traffic simulation.

Microscopic simulation results typically include density, duration of congestion, delay and travel time between pre-defined cross-sections, as well as raw data for individual vehicles as desired.

3. Evaluation of environmental impacts

Today, the responsibilities of transport engineering include the calculation of environmental impacts from traffic. In this field we need to distinguish between the calculation of source emissions and environmental impacts at the receptor level. Vehicle emissions depend on the particular traffic situation and the vehicle's engine. The measurement results are used in a matrix commonly referred to as "engine map". The calculation of environmental impacts is dependent on the characteristics and architectural landscape of the area.

The emission calculation can be performed at two different levels. The calculation on both levels will be dominated by traffic volume and fleet composition.

- The most widely used network-level computational method in Europe is the internationally recognized HBEFA.
- The highest quality of regional and local impact calculation is available by the TNO EnViVer software program.

For computing the environmental impacts it is necessary to mate the emission calculation results with a particle dispersion model.

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