MASS-GT

an empirical model for the simulation of freight policies

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MASS-GT: an empirical model for the simulation of freight policies

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INTRODUCTION

Very few systematic, quantitative and empirical methods exist which allow an impact assessment of urban freight solutions or policies. Especially the behavioral responses of logistic agents are difficult to include systematically in impact assessments. This is mainly due to limitations on urban freight data and absence of validated and proven simulation tools.

We present an urban freight simulator: Multi-Agent Simulation System for Goods Transport (MASS-GT). MASS-GT is an agent-based model consisting of a framework of discrete choice and optimization models to describe the logistic choices of shippers, carriers, producers and consumers. The disaggregate level of detail allows the analysis of a wide variety of logistic developments and policies across all or specific logistic segments. The model was first implemented for a study area in the Netherlands and calibrated and validated using a variety of data sources.

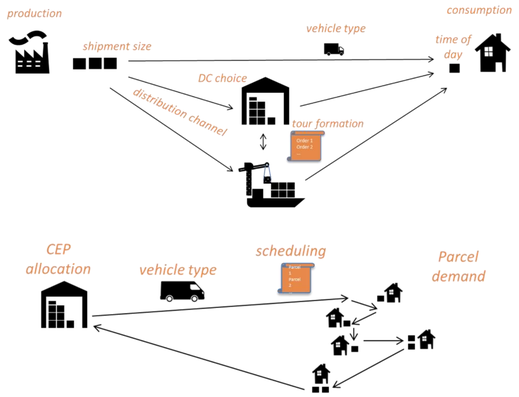
DATA USED IN IMPLEMENTATION

MASS-GT has been designed in such a way that it uses publicly available transport modelling data and statistics as primary inputs. Behavioral parameters can be calibrated, and/or validated, depending on local available data. An important data source is an automated collected truck trip diary, which is available via Statistics Netherlands for research purposes, with information at vehicle-, tour-, and shipment level (N= 2.65 M shipments). The dataset was enriched by georeferencing it to relevant location data.

	Type of data	Use in MASS-GT
Basic data:		
Traffic model of the metropolitan area	Networks, and zonal socio-economic data	Networks, employment and households at trip ends
Open Street Map (OSM)	Location parcel depots for CEP couriers	Simulation of parcel demand for delivery per parcel depots
Distribution centre database	Locations of multi modal terminals and distribution centres	Generation of freight demand at transshipment terminals and distribution centers
Strategic freight model "Basgoed"	Regional Commodity Matrix	Demand scenarios for regional commodity demand for the study area
Supply and use tables from Dutch Statistics (CBS)	Supply and use tables by product group and industry	Calculation of firm-based supplier and receiver probabilities
Survey data:		
XML truck trip diaries from Dutch Statistics	Shipments, Vehicle and tour data	Estimation of shipment size, vehicle type, tour formation, delivery time decisions
MPN household travel survey	Parcel orders by households	Estimation of parcel demand by households
Monitoring statistics about the parcel market	Parcel market statistics (historic trend)	Parcel market size by B2C and B2B segment, market shares of CEP companies
Survey in the logistic community of Rotterdam	Behavior and attitude toward zero-emission	Set parameters transition scenarios on use of ZE vehicles or consolidation hubs

CONCEPTUAL MODEL

MASS-GT models urban freight demand for two segments: general commodity shipments and parcel deliveries. The commodity demand simulation includes choices for: supplier selection, distribution channels, shipment size and vehicle type, delivery time choice, tour scheduling and vehicle route choice. The parcel delivery simulation involves the simulation of parcel ordering, CEP allocation, delivery tour scheduling.



The conceptual model and logistic choices behind freight commodity demand (top) and parcel demand (bottom).

VALIDATION

The simulated truck flows show a fair match compared to observed truck counts on the network which confirms that the simulator provides a representative prediction of freight transportation in the study area.

Sensitivity runs with the model yield a cost elasticity of vehicle kilometers of -0.10, which is considered plausible in the literature on freight elasticities. The sensitivity runs for parcel demand show that the elasticity of vehicle kilometers to parcel demand is around 0.7 which indicates stronger economies of scale. With higher delivery densities.

	Cost scenarios		
Indicator	Reference	+0.10€/km	+0.25€/km
Vehicle kilometers (trucks)	9,445,097	-0.6%	-1.8%
Average shipment distance (km)	121	-0.1%	-0.6%
	Parcel market scenarios		
Indicator	Reference	Demand +25%	Demand +100%
Number of parcels	312,793	25%	100%
Vehicle kilometers (vans)	86,720	18%	71%
C02-emissions (kg)	16,754	19%	75%

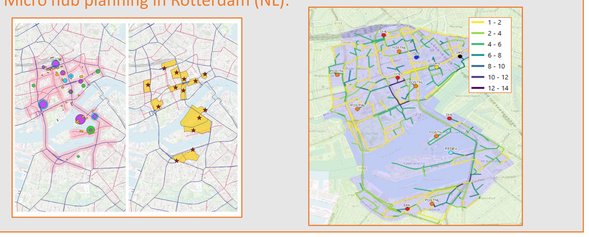
APPLICATIONS

The model has been applied in a wide range of use cases, varying from city logistic slutions to regional planning. It has also been applied in different study areas.

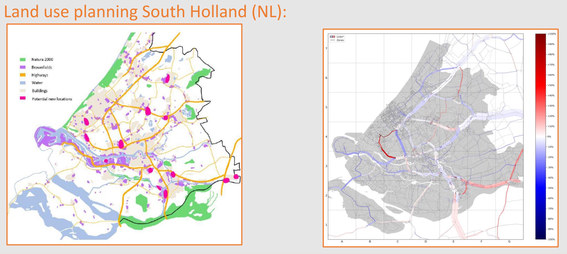
Use cases include:
- zero-emission zoning
- micro-hub planning ❶
- crowdshipping
- land use planning ❷
- parcel locker use ❸

The MASS-GT approach for micro freight (parcel deliveries) mainly requires data available publicly in most countries. The 'light' application of the model for other study areas (e.g. Rome or Thessaloniki) shows the transferability of the method.

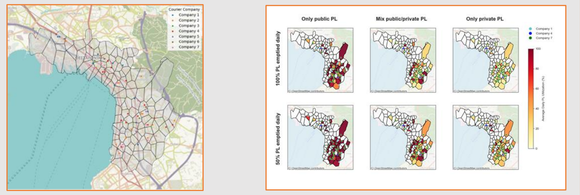
❶ Micro hub planning in Rotterdam (NL):



❷ Land use planning South Holland (NL):



❸ Parcel locker use in Thessaloniki (GR):



MASS-GT PLATFORM

The model is developed in Python and available as open-source model. With its modular structure researchers can tailor existing modules to local conditions or extend the model with new modules.

Join the community, and get access to the code of the model here:

For questions please contact: m.a.debok@tudelft.nl

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