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New Finnish National Transport Model VALMA

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Abstract

This paper introduces VALMA, Finland's new national transport model, comprising a long-distance travel model, a freight transport model, four regional sub-models, and a vehicle fleet model. Developed collaboratively using an agile, multi-consultant approach, VALMA is coded in Python and openly available. The system includes over 9,000 zones, with consistent and transferable representations of roads and transit across all model components. Travel behaviour is segmented by tour purpose rather than distance, linking most destination and mode choices to congestion in regional models, while business and overnight tours are modelled nation-wide. Finland's first freight transport model uses production–consumption forecasts, land-use data, and disaggregate mode and route choice. A directly connected fleet model captures feedback between accessibility, car ownership, and travel costs. Initial tests are promising, with ongoing calibration supported by travel surveys and mobile network data.

Background

Work on a new national transport model system for Finland began in 2022. The previously used national transport model has only 900 zones and lacks feedback between congestion and demand, making it unsuitable for regional analyses, while also lacking realistic representation of local access to long-distance train and airplane. Most regions have maintained their own models, leading to large variations in approaches and quality of the analyses. No national freight transport model has previously been publicly available.

The new model system VALMA consists of a nation-wide travel model, a freight transport model, four regional sub-models and a car-fleet model. The model system is built on the same general principles as for instance Danish GMM (Rich and Hansen 2016) and Swedish SAMPERS/SAMGODS (Beser and Algers 2002, De Jong and Baak 2016). The concept of four regional sub-models resembles the solution in SAMPERS, while the nation-wide travel model shares features with the Danish FLITMO model.

Methodology

Using an agile working method, six different consulting firms cooperate on developing the model system, predominantly sitting together in the Finnish Transport and Communications Agency's premises in Helsinki.

Network coding, data collection, model estimation and model implementation are carried out in parallel. The model system is coded in Python and is open source (<https://github.com/Traficom/valma-model-system>).

The new model system has over 9,000 zones and the network assignment is performed in EMME. PostgreSQL scripts automate the road network and line network conversion from GIS and GTFS to EMME format, and all manual corrections are saved in a GIS layer so that they can be reused in later updates.

The road and transit network is as fine-grained in the nation-wide travel model and freight transport model as in the regional sub-models. In this way, transport infrastructure projects coded in a regional sub-model can be easily transferred to the nation-wide models and analysed there as well. The short trips can also be assigned on the national network without congestion calculation, but with congestion-calculated link speeds from the regional sub-models.

The long-distance transit route choice model applies a new method for modelling of complete home-to-activity intermodal trip chains inside a mixed-mode (i.e. public-private) assignment (Kuivalainen 2024). Previous approaches have mostly either used simple heuristics to represent connection trips or modelled the route choice of connection and long-distance legs of trips separately. The mixed-mode method, on the other hand, does not require an explicit terminal choice modelling layer.

Travel mode and destination choice models are nested logit trees, with the attraction variables structured according to Daly (1982). Unlike the Swedish SAMPERS model, the VALMA mode–destination choice model does not apply a distance-based split into long and short tours. The model segments tours based on tour purpose and whether it is an overnight tour (14 different tour types in total). Most purposes describe daily travel (work, shopping, etc.) and have choices linked directly to traffic congestion calculations in the regional sub-models.

Two tour-type specifications, business and overnight tours, differ from the others. These tour types include air travel as a mode alternative, and the choice is not influenced by traffic congestion. Furthermore, travel diary data contain only a limited number of business and overnight tour observations, so to overcome data limitations, we apply two methods: Firstly, the mode–destination choice model for business and overnight tours relies on both travel diary data and separate long-distance trip survey data according to the specification presented by Bradley and Daly (1996). Secondly, the survey data for long-distance trips lacks exact coordinates of the destinations, so the model applies an extended tree structure with composite destination alternatives (Daly et al. 2002).

The freight transport model in VALMA is the first of its kind in Finland. Freight transport forecasts in the new model origin from production and consumption of goods at the county level based on a general equilibrium model, which is then broken down to the zone level using land-use data. A disaggregate discrete choice model handles route and transport mode choices, with choice parameters estimated from weighted shipment data, resembling the approach of Rich et al. (2009). A separate module handles re-routing via storage and logistics centres, applying a theoretical cost-minimization approach.

The travel and freight transport models do not feature base matrices for pivoting, as this solution was deemed as too insensitive, with the risk of hiding problems in the network assignment stage (e.g., in volume-delay functions and link capacities). Instead, the models rely on correction terms in the utility functions (Daly et al. 2005).

In addition to travel and freight transport models, VALMA contains an integrated vehicle fleet model, with an approach similar to Hugosson et al. (2014) and ITF (2020). The vehicle fleet model consists of three different submodules: a car ownership model (to define total fleet size), a vehicle scrapping model and a vehicle type choice model (to define the composition of the car fleet). The model has two links between

travel choices and the vehicle fleet: Firstly, the composition of the car fleet affects travel choices through the cost of driving. Secondly, accessibility from the mode-destination choice model affects car ownership, connecting it to transport network and price changes. This allows broad impact assessment of changes in for instance car taxation.

The car ownership model is a vehicle holding model, common in transport model systems, which explains car ownership by driver's license, income level, household composition and accessibility. The vehicle scrapping model is based on survival rates for cars of different age. In the vehicle type choice model, the choice alternatives are combinations of fuel type (EV, PHEV, petrol, diesel), vintage (new, mid, old) and size of vehicle (small, medium, large). Variables explaining the choice are purchase price, operating costs (fuel cost, mileage, taxes), household composition and housing type. Also, the effect of previous or currently owned vehicles is included.

Both vehicle scrapping and type choice models rely on car fleet data from the national Transport Register combined with person and household demographics from Statistics Finland. The database contains information of all cars and adult Finnish residents between 2013 and 2024 but includes only a limited number of explanatory variables. For example, the database lacks information on the range of electric vehicles or proximity to charging infrastructure.

Results and conclusions

The first model versions have been estimated and testing is ongoing. However, work remains in adjusting model parameters and input data, as well as in calibration. The tests show, among other things, that modelling of connecting trips in the long-distance travel model is possible to do explicitly based on the local transit network and road network. This is because Finland is relatively sparsely populated and therefore has a reasonable number of transit connections to model.

A first version of the nation-wide model for business and overnight tours has been developed, but to improve it, an additional travel survey is currently carried out. In the survey, questionnaires are distributed at major long-distance transit terminals. In addition, mobile network data will be used to calibrate the model.

The car fleet model shows how demographic variables affect the choice of car purchase. Households with children buy larger vehicles and are willing to use more money for these vehicles than households without children. Additionally, the model shows how household income levels affect the vintage of household cars.

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