Stability analysis of activity-based models: the case of Tel Aviv, Israel

Activity-based models have been implemented in various metropolitan areas. Although these models differ in their structure, input data and aggregation level, they share a general common structure. This common structure includes an individual's list of activities and trips with detailed information about departure time, destination and mode for each trip. The detailed list of trips is generally aggregated into origin-destination (OD) matrices needed for the highway and transit assignments. The assignments can be either static (as in most models) or dynamic. The assignment outputs are traffic volumes, travel times and other level of service (LOS) indices, which in turn are used as inputs to the activity-based demand model.

As with other activity-based models, the Tel Aviv model system [1] comprises a hierarchy of logit and nested logit models for all elements of person's movements, namely, activity type of main stops of all tours, times of day, destinations, modes, existence and type of intermediate stops.

The Tel Aviv model is operational for more than two years. During this period, intensive investigations were conducted regarding various aspects of model functioning and stability of results.

The application of the Tel Aviv model contains four main functional units: stand-alone Population Generator, Activity Generator, Trip Generator, and Trip Assignment.

The Population Generator produces a list of individuals, which represents population of the study area. It may be full population, or random sample often used instead of full population in order to shorten the run time.

The Activity Generator Unit applies the activity-based model of travel behavior to each person included in the synthetic population sample. As a result, each person’s daily travel is fully described and includes the types of daily tours, attributes of intermediate stops, the destinations of each activity, the modes used in different parts of each tour, and the time of day that the individual travels.

The Trip Generator Unit summarizes individual trips into mode-specific demand matrices for different periods of day. These matrices are then used as input to the Trip Assignment Unit, which performs all necessary auto and transit assignments by periods of day. The assignments are performed in the EMME [2] environment.

After preparation of the list of individuals by Population Generator, a model run is started with assignment of predefined initial demand by Trip Assignment Unit. The LOS indices obtained from assignments are used then for generating individual travels by Tour Generator, followed by creation of demand matrices by Trip Generator. Then, the assignments are made again with newly obtained demand. The base model loop is repeated several times, and after the last iteration, various reports are generated.

The Tour Generator uses random draw for simulating individual choices of travel characteristics. Consequently, the result of each iteration contains random component, and increase in number of iterations does not lead to convergence, but only decreases the influence of initial demand. A special averaging procedure should be designed to obtain the stable reproducible model results.

The paper discusses the design of such averaging procedure, focusing at implementation efficiency and error level control. Various approaches are considered, such as averaging multiple model runs, and repeated generation of individual tours for fixed LOS followed by single run of assignments.

The paper analyses the influence of sample size of synthetic population and accuracy of assignments on the model's convergence. Comparison is also made between convergence properties of link-based and path-based assignments in the activity-based environment.

The paper presents practical considerations regarding setting up the disaggregate model for optimal performance with required accuracy.

References

[1] Cambridge Systematics Inc. Tel-Aviv Activity Schedule Travel Demand Model System A Tour-Based Approach. Final Report prepared for the Ministry of Transport, December 2008.

[2] EMME On-line Documentation. Release 3.4 – 2012. INRO, Montreal, Canada.