Evaluating Transit Policy Options within an Agent-Based Microsimulation Modelling Framework

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Abstract
The TASHA (Travel/Activity Scheduler for Household Agents) agent-based microsimulation (ABM) model has been under development at the University of Toronto for over a decade using the Greater Toronto-Hamilton Area (GTHA) as its application urban region. It is an activity-scheduling model that generates and schedules all out-of-home activity episodes for all persons and households within an urban region for a typical 24-hour weekday period. The trip-chains (or tours) that are required to engage in these out-of-home activities are the emergent outcome of this scheduling process. Daily activity patterns and their associated trip-chains can be of arbitrary complexity. A unique probit-based tour-based mode choice model deals with this arbitrarily complexity efficiently, including handling sub-tours, allocation of household cars to the competing needs of household drivers, ridesharing among household members, and rail park & ride access/egress station choice at any point in a given tour. The model system is household-based in that within-household sharing of resources (e.g., cars) and duties (e.g., serving the travel needs of children) and activities (joint activities) are all endogenously modelled. TASHA has been designed so that it can either be used in a conventional travel modelling application as a replacement for the traditional four-step approach or as the transportation component within an integrated urban modelling system. It can be developed using conventional travel survey data. It was originally developed using 1996 travel survey data, was subsequently validated using 2001 data and has recently been completely re-estimated and calibrated using 2011 survey data [1,2,3,4,5,6,7].

The model system is implemented within the XTMF (eXtensible Travel Modelling Framework) software system developed at the University of Toronto to support the rapid, flexible development of travel demand models and supporting data preparation, analysis and display tools.

TASHA currently interfaces efficiently with the Emme 4 network modelling software for road and transit assignment (route choice) purposes, since Emme is the standard software used in the Toronto region, but it could readily interface with other network modelling (it has, for example, been used with MATSIM in the past). Considerable effort has been taken to maximize the policy sensitivity of the Emme transit assignment algorithms used, including sensitivity to fares and on-board vehicle and station crowding [8, 9].

GTAModel V4.0 is currently being used in a high-profile planning study to analyze a wide variety of major rail transit investment options for the City of Toronto, which has adopted the model system as their primary strategic planning tool.

ABMs are often touted as being more behaviourally sound than conventional, more aggregate trip-based methods and, hence – it is hoped – more policy sensitive [10]. This presentation discusses the application of the TASHA ABM to the Toronto transit planning case in five parts:

- An overview of the TASHA/GTAModel V4.0 design with emphasis on its strengths and weaknesses for transportation network policy analysis.
- Particular emphasis will be placed on novel features in the application of a conventional network modelling package (Emme) for advanced transit route choice modelling.
- The "policy appeal" of the ABM approach. The ability to "tell a simple a story" about how ABMs work, combined with the breadth and depth of performance measures and policy scenarios that they are capable of addressing, has been central to the enthusiastic adoption of the model system by both senior bureaucrats and politicians within the City of Toronto [11].
- The broad range of performance measures generated by the model system and their use in the planning study's policy analysis. This will be illustrated with selected results from the current Toronto rail investment study.
- Discussion of the use of ABMs to support economic benefit-cost analysis (BCA) in particular and project evaluation and decision-making in general.

References

1. Miller, E.J. and M.J. Roorda, "A Prototype Model of Household Activity/Travel Scheduling", Transportation Research Record, Journal of the Transportation Research Board, No. 1831, 2003, pp. 114-121.

2. Miller, E.J., M.J. Roorda and J.A. Carrasco, "A Tour-Based Model of Travel Mode Choice", *Transportation*, Vol. 32, No. 4, 2005, pp. 399-422.

3. Roorda, M.J. and E.J. Miller, "Assessing Transportation Policy Using an Activity-Based Microsimulation Model of Travel Demand", winner, ITE Past Presidents' Award 2006, *ITE Journal*, November, 2006, pp. 16-21.

4. Roorda, M.J., E.J. Miller and N. Kruchten, "Incorporating Within-Household Interactions into a Mode Choice Model with Genetic Algorithm for Parameter Estimation", *Transportation Research Records, Journal of the Transportation Research Board*, No. 1985, 2006, pp. 171-179.

5. Roorda, M.J., E.J. Miller and K.M.N. Habib, "Validation of TASHA: a 24-Hour Activity Scheduling Microsimulation Model", *Transportation Research A*, Vol. 42, 2008, pp. 360-375.

6. Roorda, M.J., J.A. Carrasco and E.J. Miller, "A Joint Model of Vehicle Transactions, Activity Scheduling and Mode Choice", *Transportation Research B*, Volume 43, Issue 2, 2009, pp. 217-229.

7. Roorda, M.J., D. Passmore and E.J. Miller, "Including Minor Modes of Transport in A Tour-based Mode Choice Model with Household Interactions", *ASCE Journal of Transportation Engineering*, Vol. 135, No. 12, 2009, pp. 935-945.

8. Kucirek, P. and E.J. Miller, “Modelling Toronto Transit Fares”, presented at the INRO Model City Conference, Seattle, October 12-15, 2014.

9. Kucirek, P., J. Vaughan and E.J. Miller, “Integrated Modelling with Emme using Python: The TMG Experience”, presented at the 2014 Ontario Emme Users Group Workshop, Toronto, June 27, 2014.

10. Hatzopoulou, M. and E.J. Miller, “Transport Policy Evaluation in Metropolitan Areas: the Role of Modelling in Decision-making”, *Transportation Research A*, Vol. 43, Issue 4, 2009, pp. 323-338.

11. Miller, E.J. “First We Take Toronto … Lessons from the TASHA Implementation and Next Steps”, invited presentation, Behavioural Detail and Computational Demands in Agent-Based Models Workshop, Future Cities Laboratory, Singapore, March 24-26, 2015.