Chapter 9

Activity-Based Travel Demand Forecasting Using Micro-Simulation: Stochastic Error Investigation of FEATHERS Framework

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ABSTRACT

Activity-based models of travel demand employ in most cases a micro-simulation approach, thereby inevitably including a stochastic error that is caused by the statistical distributions of random components. As a result, running a transport micro-simulation model several times with the same input will generate different outputs. In order to take the variation of outputs in each model run into account, a common approach is to run the model multiple times and to use the average value of the results. The question then becomes: What is the minimum number of model runs required to reach a stable result? In this chapter, systematic experiments are carried out by using the FEATHERS, an activity-based micro-simulation modeling framework currently implemented for Flanders (Belgium). Six levels of geographic detail are taken into account, which are building block level, subzone level, zone level, superzone level, province level, and the whole Flanders. Three travel indices (i.e., the average daily number of activities per person, the average daily number of trips per person, and the average daily distance travelled per person), as well as their corresponding segmentations with respect to socio-demographic variables, transport mode alternatives, and activity types are calculated by running the model 100 times. The results show that application of the FEATHERS at a highly aggregated level only requires limited model runs. However, when a more disaggregated level is considered (the degree of the aggregation here not only refers to the

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INTRODUCTION

Travel demand modeling was first developed in the late 1950s as a means to do highway planning. The four-step model, as the exemplification of the conventional trip-based approach, is the primary tool for forecasting future demand and performance of regional transportation systems (McNally, 2007). However, traditional trip-based approaches consider the trip as the unit of analysis, and the trip chains made by an individual are treated as separate, independent entities in the analysis, which often leads up to failure of recognizing the existence of linkages among trips. In some instances, the forecasts of trip-based approaches have proved to be inaccurate due to such an inappropriate representation of travel behaviour relationships (Jones et al., 1990). In the 1970s, the activity-based approach emerged, which explicitly recognizes and addresses the inability of conventional trip-based approach to reflect underlying human behaviour in general, and travel behaviour in particular. The approach is a richer, more holistic framework in which travel is analyzed as daily or multi-day patterns of behaviour related to and derived from differences in lifestyles and activity participation among the population (Kitamura, 1988). A full activity-based model of travel demand predicts which activities (activity participation) are conducted where (destination choice), when (timing), for how long (duration), which chain of transport modes is involved (mode choice), travel party (travel arrangements and joint activity participation) and which route is chosen (route choice), subject to personal, household, spatial, temporal, institutional and space-time constraints. (Rasouli & Timmermans, 2012, pp. 63-64) In the following 1990s, a rapid growth of interest in activity-based analysis has led up to the development of several practical models, including RAMBLAS (Veldhuisen et al., 2000a), CEMDAP (Bhat et al., 2004), FAMOS (Pendyala et al., 2005), ALBATROSS (Arentze and Timmermans, 2000; 2004), and FEATHERS (Bellemans et al., 2010). The main contribution of these activity-based models is to “offer an alternative to the four-step models of travel demand, better focusing on the consistency of the sub-models and proving increased sensitivity to a wider range of policy issues” (Janssens et al., 2008, p. 71).

However, the activity-based models, focusing on activity-travel generation and activity scheduling decisions, use in most cases a micro-simulation approach, in which heterogeneity and randomness are fundamental characteristics since they simulate individual activity patterns by drawing randomly from marginal and conditional probability distributions that are defined for the various choice facets that make up an activity pattern (Kitamura et al., 2000; Timmermans et al., 2002; Arentze and Timmermans, 2005). As a result, running a traffic micro-simulation model several times with the same inputs will obtain different outputs due to the random number seed used in each run. In order to address practitioners’ concerns about this variation, it is natural to run the traffic micro-simulation model multiple times, estimate the effects of stochastic error by analysing the variation of the outputs between the runs, and use the average value of these outputs for further analysis. The question then becomes: what is the minimum number of runs required to reach a stable result (i.e., with a certain level of confidence that the obtained average value can only vary within an acceptable interval)? In this respect, several relevant studies have been carried.