MTC’s Travel Model One: Applications of an Activity-Based Model in its First Year

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Introduction

This presentation will cover the findings and lessons learned from the first year’s worth experience using the Metropolitan Transportation Commission’s (MTC’s) Travel Model One for project applications. Travel Model One is an Activity-Based Model (ABM) covering the 9-county San Francisco Bay Area. It is part of the Coordinated Travel-Regional Activity-Based Modeling Platform (CT-RAMP) family of models, which includes members in nine locations through the US and the world. CT-RAMP provides several important advances over the first generation of ABMs by accounting for coordinated travel among household members, the availability of time windows in activity scheduling, and enhancements to allow for improved toll forecasting [1, 2, 3, 4].

Travel Model One was completed in early 2011 [5]. The model has since been used extensively for project applications, as described in this paper.

Research Contribution

This work builds upon previous sensitivity testing literature [6, 7, 8] to provide a number of real-world examples of successful applications with a new activity-based model. Over the course of less than a year, Travel Model One has been used for an extensive range of applications, showing that ABMs can be highly practical tools to serve an agency’s planning needs. The work is of interest to model practitioners who may have recently developed an ABM, allowing them to see examples of the kinds of applications that might be useful to their agencies and what kind of results they may be able to report. It is of interest to model developers to understand the sensitivity of these models to policy changes such that improvements can be made to future models.

Model Applications

In this section, the results of specific project applications are discussed. Due to space limitations, detailed results are not presented in this paper, but are available in the backup sources cited. The conference presentation will show highlights of the results of these scenarios.

Regional Transportation Plan Scenario Analysis

MTC, in cooperation with the Association of Bay Area Governments (ABAG), the Bay Area Air Quality Management District (BAAQMD), and the Bay Conservation and Development Commission (BCDC) is in the process of development Plan/Bay Area, a comprehensive regional plan for the San Francisco Bay Area. Part of Plan/Bay Area is an update to the Regional Transportation Plan (RTP). As part of this effort, two rounds of scenario analysis are being conducted using Travel Model One.

In the first round of analysis, a 2005 base year was modeled, as were 2020 and 2035 forecasts for the current regional plans and initial vision scenarios. The current regional plans scenario represents a continuation of the currently adopted plans. The initial vision scenario includes more robust transit service, combined with a land-use pattern with an increased level of households and employment.
The model results were reported across a range of dimensions [9]. Of particular interest is the vehicle miles traveled (VMT) per capita, as shown in Figure 1. Both scenarios show a reduction in VMT per capita from 2005, and the initial vision scenario shows a greater reduction than the current regional plans scenario. The difference between these two can be attributed both to the increased transit service, and to a more efficient jobs-housing balance in the land-use allocation.

**Figure 1: Per Capita VMT from First Round Scenario Analysis**

In this application, *Travel Model One* provides a few specific advantages over MTC’s previous trip-based model (BAYCAST). First the model is sensitive across a broader range of traveler responses. While BAYCAST could have predicted a change in modes and a change in destinations, *Travel Model One* is also able to predict the change in time-of-day choices, the change in number of tours and number of stops on those tours, and the travel coordination choices of households. These additional dimensions are important because the effectively capture more possible components of induced demand, which is of particular interest in evaluating the sustainability of roadway projects. Second, because the model does not have unlinked non-home-based trips, it allows all the VMT to be tracked back to the household level. This tracking allows for a better understanding of the efficiency difference of location households in different locations, as shown by the contrast between per capita VMT in San Francisco versus the other counties.
The second round of scenario analysis is currently underway.

**Regional Transportation Plan Project Assessments**

A second major component of the regional plan development was the assessment of projects for inclusion in the RTP. A key component of the project assessment was to conduct a benefit-cost (B/C) ratio for each project [10]. This B/C ratio quantifies the project impacts and costs across the following dimensions:

- Travel time,
- Emissions,
- Collisions
- Out-of-pocket user costs,
- Health costs due to level of physical activity,
- Noise,
- Capital cost, and
- Net operating and maintenance cost.

Because it is an activity-based/microsimulation model, *Travel Model One* provided an enhanced ability to evaluate two of the project impacts: out-of-pocket user costs and health costs. Out-of-pocket user costs included the cost of parking, transit fares, auto operating cost, and auto ownership. These costs were all associated with households, and the change in costs was summarized by income level. For health costs, the minutes spent in active transport were traced back to the individual level, and a valuation placed upon it. Active transport is defined as time spent walking, biking, or walking to/from transit.

A key consideration in the assessment of these projects was that it had to be completed within a limited timeframe. To accomplish this, a set of standard metrics was developed that were automatically run at the completion of each model run, and a mechanism was established to provide an automated run queue, such that the next model run would start without manual intervention, even in the middle of the night. These capabilities minimized the amount of manual intervention required, and therefore minimized the turnaround time. In addition, a constrained model was run that only included mode choice and stop-location choice changes, as well as assignment. This constrained run omitted changes in some of the upstream choices such as destination choice, workplace location, and auto ownership, but provided for the most critical responses while to minimizing runtime.

Through this effort, about 120 model runs were completed over the course of 3 months, corresponding to the highway and transit projects being evaluated.

**Traveler Response to Emission Reduction Strategies**

A series of scenarios were run with *Travel Model One* to evaluate the impact on travel-related outcomes of various strategies that could possibly be used to reduce vehicle miles traveled or emissions in the Bay Area. These scenarios include:
• **55 Mile per Hour Speed Limits**—This scenario considers the effect of changing the maximum speed limit on all Bay Area roadways to 55 miles per hour (mph), and strictly enforcing that limit. With the recognition that vehicles operate more efficiently at this lower speed, the scenario is expected to reduce mobile source emissions, and also to have wide-ranging effects on travel behavior. The change was made by setting the maximum free-flow speed in the model to 55 mph [11].

• **Increased Telecommuting**—This scenario considers the effect of increasing the rate of telecommuting. It does not speak to how travelers can be induced to telecommute, but instead evaluates the travel changes that would occur if they did. To accomplish this, the alternative-specific constant on the stay-home alternatives was increased in the coordinated daily activity pattern model [12].

• **Parking Policies**—The model was used to evaluated six parking price scenarios. The first is a 2005 base year, and the second a 2035 scenario based on the assumptions built into the current regional plans. The alternative scenarios include one in which the no travelers receive subsidized parking from their employers, one in which parking fees were increased in areas with substantial transit service, one in which there is a minimum parking fee for all destinations, and one in which a regional fee schedule was introduced [13].

• **Transit Frequency Increases**—In this set of scenarios, Travel Model One was used to evaluate the effect of targeted increases in transit frequency, for two alternative scenarios, in addition to the current regional plans. In the first, the frequency of service was increased on routes where demand is expected to increase significantly between 2010 and 2035. The second scenario includes additional increases beyond what is included in the first [14].

In each of these cases, the model was able to produce a reasonable response from travelers across a range of measures.

*Regional Express Lanes*

One of the early major project applications of Travel Model One was to provide traffic and revenue forecasts for a regional network of express lanes. The “backbone” network would include the conversion of existing high-occupancy vehicle (HOV) lanes into high-occupancy toll (HOT) lanes, and the construction of additional HOT lanes, as shown in Figure 2 [15]. Travel Model One was used to generate traffic forecasts in the corridors of interest that were fed into a revenue forecasting model. These results were used to evaluate the financial feasibility of the network as well as to feed a benefit-cost analysis of each corridor.

One critical component of this project was evaluating when the existing HOV lanes would fill with HOV 2+ vehicles, and require a conversion to HOV 3+ [16]. The ability of the model to forecast carpools was tested through this application, as was its performance as a traditional highway forecasting tool.
Currently, the Bay Area has eight major transit operators and dozens of minor operators, each with its own fare structure and payment methods. In support of the Transit Sustainability Project, it was necessary to determine whether integrating and rationalizing the fare structures would improve travel outcomes, and how it would affect revenues.

To make this determination, the transit skimming scripts in Travel Model One were modified to allow free transfers between all transit submodes. The fare paid would be the highest of the fares encountered during the trip. The model accommodated this change without too much difficulty because it already included a full set of 51 transit submodes, corresponding to the...
transit operators, and service types. The results with and without the change were tabulated to show the number of transfers between each transit operator, as well as a range of other travel outcomes.

Of particular interest in this scenario was the trade-off between different transit modes in the mode choice models, and the detailed cost sensitivity where each traveler is assigned a value-of-time drawn from a lognormal distribution.

Conclusions

Throughout these tests, the model was able to produce reasonable sensitivity to the policies being tested. The model was able to capture dimensions of traveler response that would be impossible to reasonably evaluate in a trip-based model, such as peak spreading, trip suppression due to congestion, and trip chaining. Another significant advantage to the model is that it allowed for more interesting performance measures in the project assessment and scenario evaluation portions of the RTP. Specific examples include reporting of travel time and cost changes by income level, average minutes of time spent in active transport, average out-of-pocket cost by income level, and additional equity measures.

The demonstrated success of these early applications has allowed MTC to retire its trip-based model, BAYCAST.

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