Improving Mode Choice Models with Awareness, Consideration, and Attitudes

Maren Outwater, Chandra Bhat, Raghu Sidharthan, Stephane Hess, Ram Pendyala, Thomas Adler, Jeffrey Dumont

Objectives

This research seeks to improve the understanding of the full range of determinants for mode choice behavior and to offer practical solutions to practitioners on representing and distinguishing these characteristics in travel demand forecasting models. There were three areas of further research identified in Phase 1 of this study:

- Account for the most important factors that differentiate premium transit services from standard transit services. The non-traditional attributes were identified in Phase 1 as reliability, real-time transit information, station amenities, and on-board amenities, with individual service features associated with station and on-board amenities.

- Constrain modal choices to represent those choices that travelers are aware of and among those choices, which ones they are willing to consider. The resulting modal choice alternatives represented in the mode choice model will be quite limited whereas current mode choice models include all reasonable choices as alternatives.

- Evaluate why transit riders perceive travel times differently by modal alternative and by travel time component. This research will suggest changes in transit path building assumptions on walk, wait, transfer, drive, and in-vehicle times for bus and rail modes.

The focus of this paper is on how the modeling work that was done to incorporate attitudinal factors and constrain modal choices will be put into practice. Models were estimated for each of three cities in the study and one of these will be selected for calibration and testing (Chicago, Charlotte, or Salt Lake City). In addition, we will focus on how the models will be used in forecasting.

The motivation for the research was to improve regional mode choice models by accounting for premium service attributes, recognizing traveler's awareness and consideration of alternate modes and reflect traveler's perceptions of transit networks more accurately. The primary innovations in the project are quantifying the importance of reliability, real-time information and specific station and on-board amenities and representing traveler attitudes, awareness and consideration directly in the mode choice models. The incorporation of choice set models for awareness and consideration, as well as including latent variables for these in the mode choice models is novel.

Methodology

There are two primary mode choice model improvements being tested in this research. First, how to incorporate the constraints that awareness and consideration of alternative modal options is considered by travelers. Second, how attitudes and non-traditional attributes are considered by travelers in making a modal choice. These are discussed below primarily in the context of model calibration and forecasting.
**Awareness and Consideration**

Intuitively, we recognize that awareness and consideration of alternative modes has a significant impact on mode choice alternatives, but this has not yet been put into practice. The primary difficulty has been that travel surveys have not probed travelers on what modal alternatives they are aware of or willing to consider. Figure 1 presents an example of awareness and consideration limitations on modal alternatives in a typical mode choice model. This research focused on collecting data in Chicago and Charlotte that could address these questions directly. The initial phase of the project included data collected in Salt Lake City and informed changes to the surveys for Chicago and Charlotte.

*Figure 1. Modal Choices that a Traveler is Aware of and Willing to Consider*

There are three types of models being tested to incorporate awareness and consideration into mode choice modeling:

- Joint Bivariate Probit models to model awareness of modal alternatives and consideration determined by the awareness set of modal alternatives.
Multinomial Logit Choice models to model mode choices based on the condition that a traveler is willing to consider modal alternatives. The choice set is deterministic.

Integrated Choice Latent Variable (ICLV) models to simultaneously model traveler attitudes, response to awareness and consideration or alternate modes and response to mode choice.

The awareness and consideration models indicate that awareness and consideration is almost entirely dependent on demographic and attitudinal variables, and that level of service variables are not significant in these choices. Mode choice models constrained by awareness and consideration choices are affected by level of service, demographic and attitudinal variables and have stronger behavioral statistics than mode choice models which are not constrained by awareness and consideration. These models have been estimated in draft form and are being evaluated at this time. The ICLV models are currently under development. All models will be estimated in final form by January 2012 and will be presented in the final version of this paper.

**Attitudes and Non-Traditional Attributes**

Initial analysis of the attitudinal responses for mode choice was completed using a factor analysis to predict attitudes for transit and non-transit users from demographic data. The Salt Lake City survey included 6 attitudinal statements for transit users and 9 attitudinal statements for non-transit users that were modeled to produce a convenience/inclination factor and a service availability factor for transit and non-transit users and an inconvenience factor for non-transit users only. The Chicago and Charlotte surveys included 18 attitudinal statements for all users and these were analyzed to produce 3 factors: transit inclination, transit disinclination, and environmental conservation and productivity. These three factors were subsequently included in the joint bivariate probit models for awareness and consideration and the multinomial logit choice models for mode choice.

The integrated choice latent variable models simultaneously address the 2-step process described above to include attitudes in the models as latent variables. These models allow the inclusion of attitudes in the awareness and consideration and mode choice models from their source instead of first calculating factors and then estimating models with these factors. The advantage of this modeling approach is that the attitudinal factors are estimated simultaneously with other choices. Comparison of this modeling approach with the initial 2-step process will be provided in the final paper.

There were 23 non-traditional attributes included in the Chicago and Charlotte case studies and 21 attributes in the Salt Lake City case study using Maximum Difference Scaling methods. The individual attributes were too numerous to include in the mode choice models directly, so the attributes for station and on-board amenities were bundled allowing for the maximum difference analysis to identify the marginal rates of substitution for individual attributes scaled to the bundled coefficients in the mode choice models. The non-traditional attributes included in this analysis are:

- Station/Stop Amenities (station/stop lighting/safety, station/stop shelter, proximity to services, cleanliness of station/stop, station/stop benches, and station/stop security)
- On-Board Amenities (WiFi, on-board seating availability, on-board seating comfort, on-board temperature, and cleanliness of transit vehicle)
- Reliability
- Transit Real-Time Information

This analysis allows us to distinguish the equivalent minutes of in-vehicle time for each of the attributes at the stations and on-board. In the Salt Lake City case, shelter at the station was most
important for work trips and proximity to services was most important to non-work trips of the station attributes and seating availability was the most important on-board attribute. The attributes most important in Chicago and Charlotte will be reported and compared in the final paper.

**Implementation**

One additional aspect of this research is the demonstration of how these new models will be put into practice by implementing the models in one of the case study cities. This will involve calibrating the modal constants and testing market segmentations for bias in the mode choice models when compared to observed modal shares. The calibration results will be useful to understand the size and importance of the alternative specific constants, since one objective of the study is to minimize these. The calibration effort will also involve assigning transit trips, which will lead to an understanding of whether the transit path building assumptions are adequately specified.

The calibrated models will be tested in a base year setting to understand the responses in the model to changes in the newer, non-traditional variables and those new features of the mode choice models. These sensitivity tests will be used to verify the approximate size and direction of mode choice and transit ridership results. These will be interpreted as reasonable if the size and direction of the results are within expected ranges. These sensitivity tests will be designed specifically to evaluate characteristics of premium transit services and their overall impact on modal choices.

**Expected Major Results**

The results of this research will be recommendations for enhancing mode choice models and guidance on the impact that specific transit service characteristics will have on travel behavior. The enhancements to the mode choice models will be focused on accounting for awareness of alternate modes, how travelers determine what modes they are willing to consider, and what transit service characteristics or attitudes (beyond travel time and cost) are important in the final mode choice decision. The incorporation of awareness, consideration, and attitudinal variables in the mode choice models will provide guidance for those agencies who want to incorporate them into their mode choice models. We will provide equivalent minutes of in-vehicle time for these non-traditional service characteristics so that transit planners may consider these characteristics within or outside a travel demand forecasting model. For those agencies who conduct travel surveys, the data collection used to develop these new models can provide guidance for future data collection activities.

**Implications for Travel Modeling Practice**

The research conducted in Phase 1 of this study clearly identified that awareness and consideration significantly limit the alternate modes that travelers are considering in their modal choice and these new mode choice models would demonstrate how transportation planning agencies could adapt or refine their mode choice models to reflect this fact. In addition, the results identify how much travelers' value specific aspects of transit (reliability, real-time information, on-board and station amenities) and how to incorporate this information in travel demand models. The parameters estimated across the 3 case study cities will help to provide a range of expected parameters for other areas. While this research was conducted using trips rather than tours, the adaptation to activity-based models would not be difficult, especially if new data collection activities are revised to incorporate awareness, consideration and attitudinal questions.