

Project: Front Range Passenger Rail Service Development Plan and National Environmental Policy Act (NEPA)

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To: FRPR Project Management Team

From: Erik Sabina, CDOT

Subject: FRPR Travel Modeling Methodology

INTRODUCTION

In the fall of 2019, the Colorado Department of Transportation's (CDOT) Travel Modeling Unit began using its new statewide travel model to conduct scenario analysis for the Front Range Passenger Rail (FRPR) project. Work on the FRPR constituted the first use of the statewide model for a major corridor study, whether highway or transit. CDOT's statewide model has been under development for several years, and was completed in draft form early in 2019. The model was adapted for statewide use from the Denver Regional Council of Government's (DRCOG) "Focus" model, which has been DRCOG's standard modeling tool since 2010.

MODEL STRUCTURE

CDOT's statewide travel model is of a type known as "activity-based" models, a class of models that are becoming the standard in the US in large metropolitan areas, and also are beginning to be adopted at the state level. Over the past 20 years, activity-based models have gradually been replacing "trip-based" models, which were the global standard for several decades prior. CDOT's activity-based model possesses several key features that make it well-suited to multi-modal corridor and area analysis:

- People/households and jobs are modeled at the individual level, allowing the model to be sensitive to individual/demographic differences.
- The model builds a complete daily travel diary for each person, showing the interconnection between trip as each person goes from place to place (to place).
- The model includes both motorized and non-motorized modes in its choice components.
- Seven different trip purposes are included in the model, enabling a detailed depiction of the effects of different travel purposes on location choice, mode choice, etc.
- All model choice components include a rich set of "explanatory variables" (trip time, cost, etc.) that provide the model with sensitivity to the factors that most affect peoples' travel choices.

While CDOT’s model was in a sense newly developed just before commencement of the Front Range Passenger Rail study, in another sense it is well-seasoned: its overall structure was borrowed from DRCOG, which has been using this same model structure for ten years. CDOT did implement some enhancements to the DRCOG model to better suit it to state/inter-regional use, including:

- Depiction of tours (several trips linked into a round-trip) that span more than one day
- Reinforcement of the model’s depiction of trips made by visitors
- Development of a post-model spreadsheet tool to estimate boardings from weekend trips, and boardings for special-purpose travel such as stadium events (such trips are not depicted in the standard model, which depicts “typical” weekday travel)

Figure 1: CDOT Travel Model Components and Flow

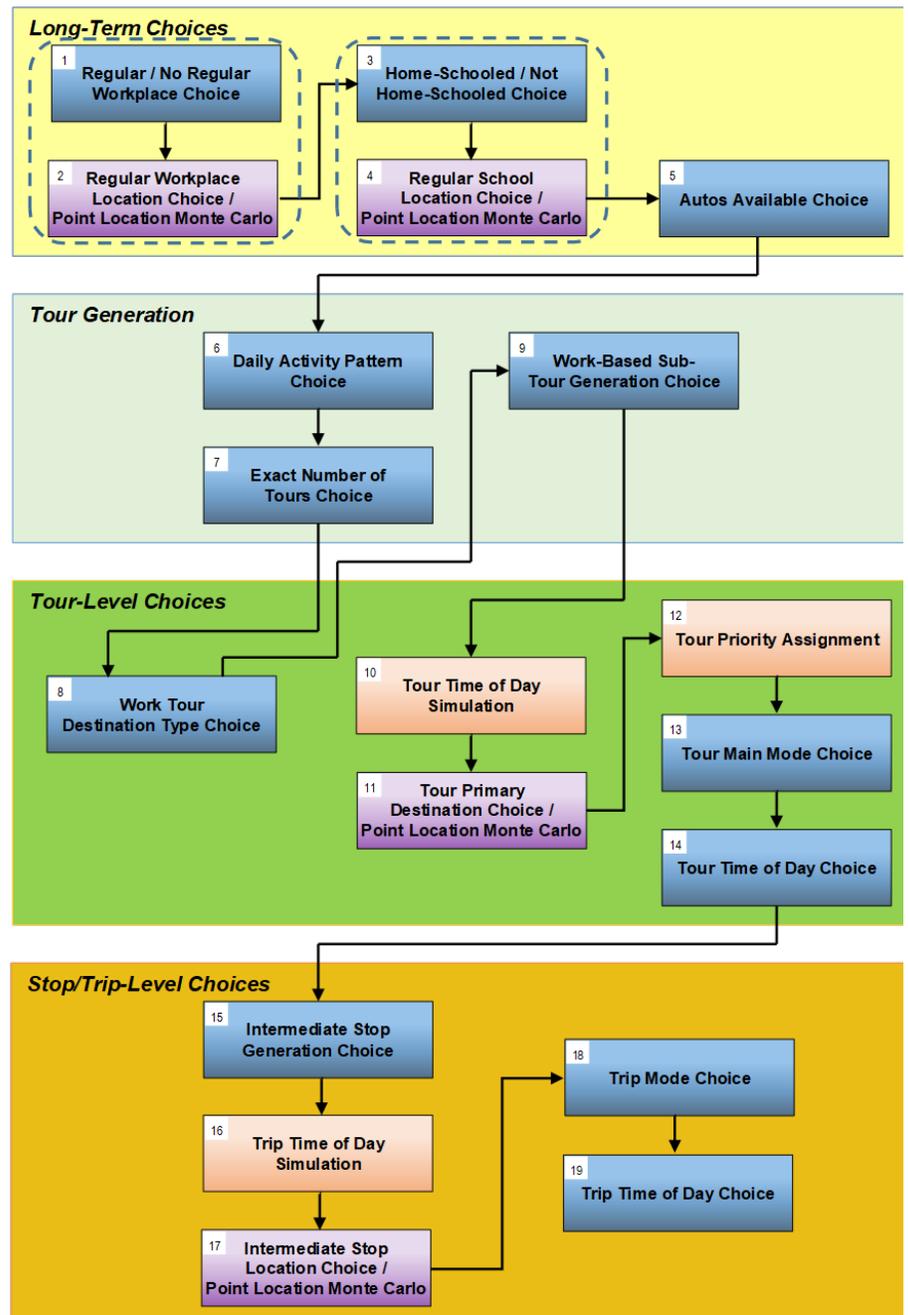


Figure 1 shows a diagram of the major components of CDOT’s model.

MODEL DATA

CDOT's statewide model was developed based on a large, diverse body of data gathered in Colorado (that is, not borrowed from other states), with key elements of these data gathered for the specific purpose of building models of this sort:

- The CDOT model also was “re-estimated” (sensitivities re-calculated to model variables such as cost and time) based on the latest available survey data: the Front Range Travel Counts survey, conducted in 2010, which covered the entire Colorado Front Range region. This survey gathered data from approximately 30,000 Coloradans.
- The model depicts land use (households/people/jobs) at a high level of demographic and geographic detail. Households/people are depicted at the level of detail available in the US Census, developed using a “synthetic population generator.” Jobs are depicted in one of six different industry categories, founded on the Colorado Department of Labor and Employment’s Quarterly Census of Employment and Wages data (QCEW). All households and jobs are located at individual addresses (precise latitude/longitude locations.) Forecasts of state population/household/job growth are taken from the Colorado State Demographer’s Office.
- CDOT has also used “big data” from Streetlight Data to enhance the model’s ability to depict trips along the Front Range for visitors, special event trips (stadium events, etc.) and trips to Denver International Airport (DEN).
- Highway networks in the model include all roads of Collector or higher functional class in the state. Within metropolitan planning organization (MPO) areas, the networks are taken from the MPOs. Outside MPO areas, CDOT has built networks “from scratch.”
- Transit networks also are taken from MPOs, where the MPO models have transit networks (in one or two cases in which the MPO models don’t have transit networks, CDOT built them.) Outside MPO areas, CDOT acquired route system data from numerous transit operators and built their routes into the state network.
- The model uses numerous traffic counts from CDOT’s count program as part of the process of calibrating the model.
- CDOT also obtained transit boardings from numerous operators all across the state, also as part of the model calibration effort.

MODEL CALIBRATION/VALIDATION

After the model was built in its draft version, it was subjected to an extensive program of calibration and validation. Briefly described:

- Calibration is the process of comparing the model's results to a separate set of observations, to see how well the model matches those observations. Calibration is conducted for the same year as the year during which the survey data was taken (2010).
- Validation is a similar process, conducted for a different year (2015), to evaluate how well the model displays sensitivity to changes that have happened during that time interval.
- As one of the key outcomes of the travel model is its estimate of volumes on roads, one key calibration/validation element is comparing model road volumes to traffic counts, and making adjustments if necessary.
- A similar calibration is carried out regarding transit results, comparing the modeled to observed boardings, and adjusting as necessary. Boarding comparisons are conducted at a variety of levels of detail, often at the individual transit line level.

In summary, the purpose of these activities is to ensure that the model's results compare reasonably to independently-observed data, and that its sensitivity to changes (in land use, in transportation, etc.) is also reasonable.

INITIAL WORK

When technical work commenced on the FRPR project, the CDOT modeling group first executed an initial test run, using rough draft service characteristics provided by the project planning leadership. This run was subjected to a detailed evaluation of its outcomes, to search for flaws both at the large and small scales. This effort also involved comparison to other modeling work done in the corridor, again to judge the reasonableness of the model's outcomes. Key elements in this work included:

- Comparison to the Interregional Connectivity Study (ICS)/Advanced Guideway System model outcomes (CDOT, 2014). Reports from that study, which considered ridership on a high-speed transit system along the Front Range and I-70 Mountain Corridor, were scrutinized carefully, as was data obtained directly from the consultant who conducted modeling for the study. While CDOT's model outcomes showed significantly lower ridership than the 2014 study, CDOT's evaluation concluded that current modeling efforts were reasonable. Reasons for the lower ridership included slower speeds and associated longer travel times in the current effort, as compared to those assumed in the 2014 work.
- Scrutiny of the many parameters involved in estimating transit mode share and paths through the network. For example, adjustments were made to the "bias coefficient" that depicts the extent to which transit riders prefer rail, including light rail transit (LRT) and commuter rail transit (CRT) to bus travel, so that total LRT and CRT modeled boardings closely matched observed boardings.
- Upgrade of the model to enable it to model in the same manner both "transit drive access" trips (for examples, trips that access transit by driving to a park-n-ride lot) and "transit drive egress"

trips (the return trip made by someone who made a drive access trip). This upgrade resulted in better balance between drive access and egress trips at park-n-ride lots, and required upgrade of the model to use a new version of TransCAD (version 8.0, build 22410).

- Adjustment of north I-25 tolls in the year 2045, to be consistent with expected toll levels for that year (to ensure a more realistic depiction of the mode competition between use of the rail line and the toll lane.)

The implementation of these and other similar enhancements, combined with careful comparison of model results to observed boardings on similar services in other parts of the country, has resulted in a model that produces reasonable rail ridership estimates that provide effective support to FRPR project planning and engineering efforts.

CDOT conducted and documented numerous model runs, showing preliminary ridership ranging from about 1.5 million to 2.9 million riders per year, depending on the alignment and operating assumptions. Summary files of the results are available from CDOT.