Draft

**TDOT Travel Demand**

**Model Application Checklist**

Daniel A. Badoe

Professor

Department of Civil and Environmental Engineering

Tennessee Technological University

Cookeville, TN 38505

Chin-Cheng Chen

Transportation Coordinator

Long Range Planning Division

TDOT

Nashville, TN 37243

Jerry Everett

Research Director

Center for Transportation Research

University of Tennessee

Knoxville, TN 37996

Fred Wegmann

Center for Transportation Research

University of Tennessee

Knoxville, TN 37996

# TDOT Travel DemandModel Application Checklist 1,2

## MODEL DESIGN AND BACKGROUND INFORMATION

1. Base Year Roadway Network:
2. What are the:

\_\_\_ Base Year

\_\_\_ Future Year

1. What are the data sources utilized for the base year network? TRIMS’s, Tel-Atlas, etc.
2. What are the data sources and procedures utilized for calculating:
	* + Capacity – Daily and Peak Period
		+ Free Flow and Initial Congested Speeds
		+ Turn Penalties and Terminal Times
3. Has the MPO reviewed the following model network components:
* Centroid Locations
* Centroid Connectors
1. Base Year Socio-Economic Data:
	1. What are the:

\_\_\_ Base Year

\_\_\_ Future Year

* 1. What are the base year area wide and zonal data sources:
* Total Population
* Total Employment
* Household Size
* Vehicle Ownership
* Students (if appropriate)
* Income (if appropriate)
1. Future Year Socio-Economic Data
2. What are the future year area wide data sources?
* Total Population
* Total Employment
* Household Size
* Vehicle Ownership
* Students (if appropriate)
* Income (if appropriate)
1. How did areawide control total compare with those utilized in the Statewide Model?
2. How were items in 2-b above allocated to zones? Were vehicle ownership models, etc., utilized? If so, please describe or cite “references”.
3. Was a land use model utilized? If so, please cite reference.
4. Travel Demand Model Structure:
5. Is the Model:
* A trip distribution or logit destination choice model?
* Includes a mode choice model type? (if so, specify type of logit model and refer to Appendix A).
* Includes a truck or freight model (specify classes of vehicle types utilized).
* Includes sub models for special purposes (students, long distance travel, airport travel, etc.).
* A time of day or peak period model.
1. Definition of Traffic Analysis Zones (TAZ’s):
* Number of TAZ’s
* Area types utilized
* Districts utilized
1. Number and location of extended stations

## TRAVEL DEMAND FORECASTING PROCEDURES

* + 1. Trip Generation:
	1. Sources of Trip Generation Relationships and Citation of:
* Trip production relationships
* Trip attraction relationships
	1. Performance/Reasonability Checks for Trip Generation:
* Review the trip production/attraction balances
* Review total trip productions per household for reasonableness – some typical ranges of production rates from previous survey efforts are shown in Tennessee Model Guidelines
* Calculate total trips by purpose and compare percentages by trip purpose to the ranges provided in Tennessee Model Guidelines
* Review home-based work trip attractions per total employment
* Review home-based school trips per school enrollment (if used)
* Review home-based shopping trips per retail employment (if used)
* Calculate trip rate per capita (total trips/population). This value should be over 3.0 and generally in the range of 3.5 – 4.0.
	+ 1. Trip Distribution:
1. Sources of Trip Distribution Relationships and Citation of:
* Trip length distribution by trip purpose
* Appropriate impedance variables utilized
* Congestion speeds utilized
1. Performance/Reasonability Checks for Trip Distribution:
* Review average trip lengths by trip purpose for reasonableness based on the knowledge of the planning area. Average travel speeds can be calculated by dividing the average distance for each trip purpose by the average travel time for each trip purpose and multiplying by 60.
* Plot trip length frequency distributions for each trip purpose and check for reasonability.
* If “K factors” were utilized, identify the applications and rationale.
* IntraZonal Trip Percentages
1. Destination Choice (If Applicable):
* District Map, District Information
* Size Terms
* District Level observed trip and modeled trip
* Assumed Congestion Speed Used
* Destination Choice Model by Trip purposes result and statistics
* Area Type, River Crossing, Rail Road Crossing variable
* Impedance Variables
* Model Validation Target and Results
* Performance/Reasonability Checks for Trip Distribution (see B-2-b above)
	+ 1. External Trips:
			1. Methodology
* External Station AADT, I/E, E/I, and E/E Percentage by Vehicle Types
* External Trip Time of Day Factors
* External Trip Balance and Growth Factor Methodology
* External Trip Distribution Method
* External Trip Assignment Method
	+ - 1. Performance/Reasonability Checks for External – External and External – Internal Trips:
* Review external – external trips to total study area trips
* Review external – internal trips to total study area trips
	+ 1. Freight or Truck Component (if Applicable):
			1. Data Source
			2. Methodology Utilized
		2. Sub Model Used (eg: Airport, Visitor, Student, and/or Group Quarter Submodel)
			1. Data Sources
			2. Methodology Utilized
		3. Mode Choice Models are Tracked Separately:

See Appendix A

* + 1. Traffic Assignment and Validation:
			1. Data Sources
* Time of day table (return and departure trip percentage)
* Vehicle Occupancy Rates
* Volume Delay Function
* Assumed Congested Speeds
* PCE used for Trucks
	+ - 1. Assignment Results and Methodology:
* Has the MPO provided an overall evaluation of the model and calibration results for reasonableness?
* Were the minimum Travel Demand Model Calibration and Validation Guidelines for Tennessee followed? If not, what are the differences:

x Coefficient of Determination (Figure 2)

x Percent difference in value for screenlines (Table 5)

x Percent difference in value for link volumes (Table 5)

x Percent difference in volume by classification (Table 6)

x Root mean square for link volumes (Table 10)

 Where FHWA and Michigan criteria are provided it is suggested the FHWA criteria be selected.

* + Tennessee MPO’s and TPO’s in the preparation of their long range plan are encouraged, where practical, to consider the following test which will be considered for inclusion In the future draft of the calibration/validation guidelines.

x Modeled versus observed VMT by functional classification (Table 9)

x Root mean square by functional classification (Table 11)

x Peak hour validation targets

x Sample size documentation

* + Screenline/Cutline Validation:

Screenlines, which are traffic flows that are found on parallel facilities or within a corridor, are developed in the model to determine validity.

x Has the location of screenlines and cutlines been documented?

x Are the screenlines and cutlines consistent with best practice and will be applicable to model validation?

x Has the MPO provided link-by-link screenline and cutline results and totals?

## TRAVEL DEMAND MODEL RESULTS and DOCUMENTATION

1. Definition of E & C Network Scenarios:
* Definition of E&C Project
* List of E&C Projects and Locations
1. Model Result
	* Base Year Volume/Capacity Map
	* Horizon Year Volume/Capacity Map and Reasonable Checks
	* Intermediate Years Scenarios with Volume/Capacity Maps
2. Were post processors utilized, documented, and consistent with the statewide model
	* Traffic Volume
	* Travel Speed
	* Travel Time
3. Has the MPO checked to see if results for the new study/plan are consistent with the work done in the past for the same study area? For example, comparisons of the free flow speeds or over capacity, link and travel time reasonability checks. If the results are different, has the MPO documented the reasons why?
4. Were Model Files, Documentation of the Model UI and Script Provided in the Final Model Package before the Final Review:
* Model Inputs for Base and all Scenario Years
* Model UI, Script and the Source Code included
* UI Installation Manual
* How to obtain the model result (join the output file, or in the network)
* Scenario Coding Manual, new road, road widening, transit route modifying
* Select Link/Select Area Analysis document
* Folder, File, and Field Dictionary
1. Virginia Transportation Modeling Policies and Procedures Manual. Virginia Department of Transportation. 2009
2. Guidelines for Developing Travel Demand Model & Small Communities. North Carolina Department of Transportation. 2007
3. Minimum Travel Demand Model Calibration and Validation Guidelines for the State of Tennessee – Updated 2012. University of Tennessee. 2013

# APPENDIX A

## MODES CONSIDERED, MODEL STRUCTURES, AND DATA SOURCES

1. Modes to be considered in mode choice models:
* Where motorized transportation modes only are of interest: (Auto and Transit)
* Where motorized and non-motorized transportation modes are of interest:

Auto, transit, non-motorized transportation (Auto, transit, bike, walk)

* Where HOV is of interest; where access mode to transit is of interest; where non-motorized transportation modes are of interest: (Auto – drive alone, HOV; transit – walk access, auto access; bike, walk)
1. Source of Base Year Transit Network:
* Transit Routes
* Park and Ride Locations
* Headway
* Dwell time
* Fares
* Transit Speeds
* Walk Connectors
* Costs
* Roadway Speed Utilized
1. Source of Data and Model Structure:
* Onboard Survey and Analysis – cite references
* Market Segment’s Considered
1. Variables specified in the transport mode utility functions:
	* Level of service variables specified are in-vehicle travel time, out-of-vehicle travel time, out-of-pocket travel cost.
	* Level of service variables specified are in-vehicle travel time, walk access and egress times, wait-time, transit transfer time, in-vehicle travel cost, parking cost, number of transfers for travel by transit, trip-distance.
	* Level of service variables (as above) and socioeconomic attributes (household income – if available, household vehicle ownership, number of workers, gender, etc.).

## Reasonableness Checks on Estimated Mode Choice Model Parameters

Sign of each estimated level-of-service variable-coefficient should be consistent with travel behavior theory.

Ratio of estimated coefficient of out-of-vehicle time to estimated coefficient of in-vehicle time should exceed 1 (the ratio is usually between 2 and 3).

Check implied value-of-time (ratio of estimated coefficient of in-vehicle time to estimated coefficient of travel cost) in dollars per hour. Compare to range for typical values.

In nested logit models, the estimated coefficient of the log-sum term must lie between 0 and 1.

## VALIDATION CHECKS

* Market segment prediction test: Compare the predicted frequencies/shares of the transportation modes to their observed frequencies/shares in defined market segments. The segments could be defined based on gender, income, vehicle ownership, etc. Deviations from the observed should not exceed two standard errors.
* Obtain the predicted trip length distribution for trips by transit and compare it with the observed.
* Policy sensitivity test of model: Check the policy sensitivity of the model by making a significant change to a system attribute and determining whether or not the resulting transportation mode forecasts given by the model are reasonable. Clearly, this requires data from previous such changes and the traveler responses to such changes to establish a range of what might be considered reasonable.
* Compare modeled ridership results vs observation by route.