Development of Travel Demand Model Standards

Phase 1 & Literature Review
Draft Consultant Recommendations

Tennessee Model Users Group
Mt. Juliet, Tennessee

May 19, 2022
TDOT Long Range Planning Division

Matt Meservy, PE, Long Range Planning Division Director
David Lee, Ph.D., Long Range Planning Assistant Director
Mohammad Molla, Ph.D., Forecasting Planning Supervisor
Ken Kaltenbach, PE, The Corradino Group, Inc.

TN TDOT Department of Transportation

Welcome

- TDOT Long Range Planning Division
  - TDOT Staff
- Introduction to the study
  - Ken Kaltenbach, PE (The Corradino Group)

TN TDOT Department of Transportation

Recap: Project Scope and Purpose

The main purpose of the study is to create modeling standards to facilitate easier review and application of the models. The consultant will conduct this effort in close coordination with TDOT staff, thereby providing instruction and training.

Phase 1: State-of-the-art Literature Review	**<- This Effort**
Phase-2: Development of the Model Package	<- Later
Phase-3: Statewide Integration	<- Later

TN TDOT Department of Transportation

Report Contents

- Introduction
- Meetings and Coordination
- Survey of Tennessee MPOs
  - Summary Results
- Summary of Current Tennessee MPO and Statewide Models
  - Assessment and Commentary
- Travel Model Improvement Program (TMIP) Outreach
- Other Contacts and Discussions
- Literature Review
- Preliminary Recommendations
  - General Conditions
  - Model Framework, Guidelines, and Visualization
    - Models by Classification
    - Graphical User Interface (GUI)
    - Data File and Attribute Naming
    - Model Features
  - Data Resources
  - Road Map and Schedule
    - Confirm and Adjust the Phase 1 Plan
    - Develop One Prototypical Model

TN TDOT Department of Transportation

Advantages of Standardization

- Advantages
  - TDOT develops the procedures one time. The MPOs have to do less.
  - TDOT provides much of the required data.
  - Programs/scripts and maps will be common.
  - Everybody speaks the same language. Training is easier.
  - TDOT and the committee can specify targets.
- Disadvantages
  - One size may not fit all.
  - Harder to address special local situations.
  - More difficult to take advantage of new tools.
- Possible solution: flexible guidelines within overall standards.

TN TDOT Department of Transportation

Standards vs. Guidelines

- No state forces the use of standards. Most states, including Florida, have moved from rigid standards to more flexible guidelines.
- Most states entice MPOs to use their guidelines by providing technical support.
- The TN MPO survey showed a preference toward the use of guidelines.

TN TDOT Department of Transportation

MPO Survey

- Purpose: understand MPO interests and needs.
- Results
  - Most MPOs think it is useful and want to participate
  - Everybody needs data, staff, and training
  - Everybody wants more accurate forecasts
  - Easier model application is a high priority
  - Model run time is not an issue
  - Priorities vary between MPO sizes
  - Most like guidelines over standards

TN TDOT Department of Transportation

MPO Survey

- Most Pressing Modeling Needs
  - Most MPO's say they need more data, staff, and training.
  - Almost all MPO's say they need more accurate traffic forecasts.
  - Most say that easier model application is a high priority.
- Most MPO's believe that a system of similar modeling procedures among the MPO's with TDOT support would make their jobs easier.
- Usefulness of possible improvements: (ranked)
  - Better and more consistent data was ranked first by small- and medium-sized MPO's, and second by the large MPO's.
  - Consistent data file and variable names was ranked first by large MPO's and second by medium-sized MPO's.
  - Consistent procedures were ranked least important by medium and large MPO's, and second by small MPO's.
- Additional data needs
  - Ranks vary widely by size
  - Large MPO's ranked household surveys and external data highly.
  - Medium MPO's expressed their need for more zonal data and traffic counts.
  - Small areas say they need more traffic counts, network data, and a household survey.
- New procedures and post-processors
  - All MPO's expressed a need for land use forecasting.
  - Air quality tools are important for large area but not for small and medium sized areas.
  - Economic analysis tools are needed, especially for small and medium sized MPO's.
  - Visualization tools rank lower than expected.

MPO Survey (Continued)

- Guidelines versus Standards
  - Large and medium MPO's prefer guidelines over standards.
  - Small areas are evenly split.
- Definition of a good model
  - Logical/reasonable is rated more important than exact replication for all 3 sizes of MPO's.
  - Produces good summaries, maps, graphs and other visualization outputs is ranked as important by small and medium MPO's.
  - Models that run quickly are important to large MPO's.
- Overwhelmingly, MPO's are interested in using a standard TDOT model.
- Elements to be standardized
  - Large and small specify file standard names.
  - Medium sized MPO's are most interested in a standard set of model steps.
  - Standard algorithms and constants are important for all MPO's.
  - Standard transit and non-motorized models rank low.
- Interest in Serving as Part of a Committee
  - The majority of medium and large MPO respondents were interested in serving.
  - Most small area respondents were not interested in serving.

States with Standard Models

- California
- ***Florida***
- Georgia
- Illinois
- ***Iowa***
- Kentucky
- Maryland
- ***Michigan***
- North Carolina
- Ohio
- Oregon
- ***Texas***
- *Virginia*
- ***Wisconsin***
- Others?

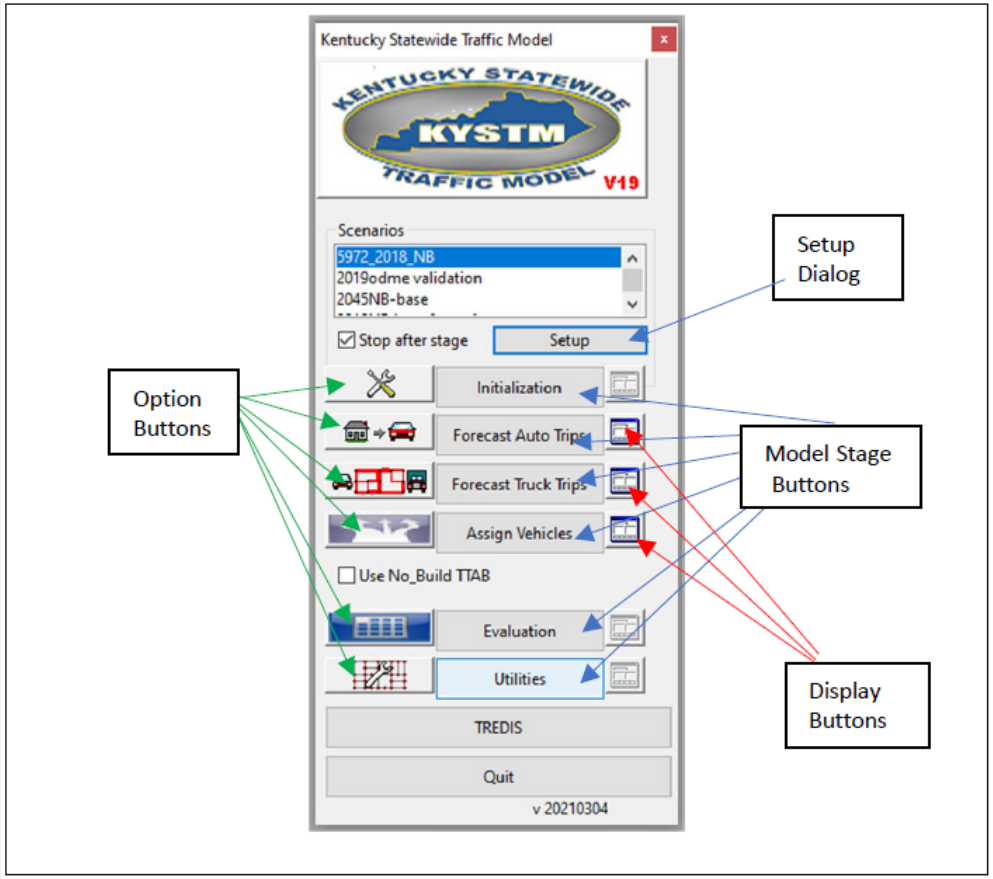
TN TDOT Department of Transportation

Proposed Model Summary

Model Feature	Highway Only	Multi-Modal	Advanced Practice
- Caliper Graphical User Interface	X	X	
- TRIMS-based highway network: master network system	X	X	X
- Transit networks from GTFS, with routes and headways for all periods	X	X	X
- Data file and attribute naming guidelines	X	X	
- TAZ system based on Census geography, nested with statewide model	X	X	X
- Eventual development and use of a statewide land use model	X	X	X
- Household model to produce joint distributions	X	X	
- Trip Generation			
- Cross-class productions	X	X	
- Rates for attractions	X	X	
- Purposes; HBW, HBU, HBSC, HBSP, HBSR, HBPD, HBO	X	X	
- NHB split into NHBW & NHBNW linked to home based attractions	X	X	
- EE, EI, Truck (SU, CU)	X	X	
- Nested logit Mode Choice: Transit modes, DA, SR2, SR3+, non-motorized modes		X	
- Distribution by Destination choice	X	X	
- Post distribtion TOD Model (4 periods)	X	X	
- Highway assignment by TOD and Vehicle Type	X	X	
- Strict capacity restraint convergence (0.001)	X	X	
- BPR vdf by functional class	X	X	
- N-conjugate BFW	X	X	
- Selectd link/zone optional	X	X	
- MSA travel time feedback for all time periods	X	X	X
- Transit Assignment after feedback convergence		X	
- Detailed reporting & visualization automatically created after convergence	X	X	X

TN TDOT Department of Transportation

New Features - Standard GUI (not final)



Tennessee Model Comments

(Based on contrasting TM models)

- Tennessee models are generally consistent among themselves – dependent on authors
- Network data sources are consistent: TRIMS with HPMS, NPMRDS, HERE
- All appear to use four time periods
- Three advanced practice models
- One trip model with transit
- Other trip models do not have transit models, but all but one of these MPO's have fixed-route transit system. ** Add transit
- If transit is added there will be only one highway-only model
- Models without transit networks use a gravity model. ** Add destination choice
- All but 3 models do feedback on travel time ** Add feedback
- Most validation metrics are in expected ranges, but reports are not consistent
  ** Add consistent reporting & visualization
- TSM_V4 is very complete. The "Pivot" method would be a useful addition to other models: essentially, remove base year assignment error.

TN TDOT Department of Transportation

Folder/File/Attribute Names

Standard names will be developed during the development of the prototypical model

Model folder structure:

TnTown (MPO Model Name)

- **GISDK** – To hold the code for the model resource (*.rsc) file. Other files stored here would be the compiled script (seven files), and the ".def" file.
- **Common** – This folder would contain files that are common to all scenarios. Examples would be speed and capacity tables, trip rates, mode choice constants, and other files that do not change.
- **Master** – This is the folder that contains the master network and TAZ geographic files and data. Eventually, this might be the Tennessee Statewide Model, which would hold all network and TAZ modeling data for Tennessee. Other files might reside here, like the base year external-external trip table.
- **Alternative folders** – A folder should be created for each alternative. The name should be short but should designate the identifier ("A", "B", "Base", "EC", etc.) and the 4-digit year. There should be three subfolders under each alternative.
  - **Input** –All input data and geographic files.
  - **Output** –All output data files. The model should be scripted to create this folder if it does not exist, and to create all files written to this folder.
  - **Temp** – This folder would hold temporary, intermediate files that may be created and used by the model but not needed otherwise.
  - **Reports** – This folder would hold all reports and visualization files
  - **Documentation** – Model documentation

Other Model Features

- Networks and TAZs
  - Networks – develop alternatives from a master network
  - Keep TAZ data in a master file
  - Develop a land use model (Phase 3) with TSM integration
- Trip Generation
  - Cross-class productions
  - Trip rate attractions
  - HH: persons, workers, income. children
  - Use a household model for joint probabilities
  - Employment: grouped by NAICS codes
  - Develop NHB (NHBW, NHBNW) trips from home-based attractions, modify by accessibilities

Other Model Features

- Trip types
  - Internal Home-Based Trips
  - Internal Non-Home-Based Trips
  - Special generators
  - External-External (through) Trips
  - External-Internal and Internal-External Trips
  - Truck Trips (addressed in another section)

- Internal trip purposes
  - Home-based work (HBW),
  - Home-based university (HBU),
  - Home-based school (HBSC),
  - Home-based shopping (HBSP),
  - Home-based social-recreational (HBSR),
  - Home-based pick-up drop-off (HBPD), and
  - Home-based other (HBO).

TN TDOT Department of Transportation

Other Model Features

- Nested Logit Mode Choice
- Trip distribution by destination choice
- Four time periods, post-distribution
- Highway assignment
  - “MMA”: DA, SR2, SR3+, transit models, non-motorized modes
  - N conjugate BFW
  - Converge to 0.001
  - Add selected link, static trip tables

TN TDOT Department of Transportation

Other Model Features

- MSA feedback on all 4 time periods
- Same seed skims and times to speed up runs
- Assign transit trips after convergence
- Create reports and visualization after convergence

TN TDOT Department of Transportation

Standard Reports for Every Step

(TransCAD XML)

- Zonal data
- Highway and transit networks
- Trip Generation
- Mode Choice
- Destination Choice
- Highway assignment
  - Validation
  - Evaluation

TN TDOT Department of Transportation

Visualization – TransCAD display buttons

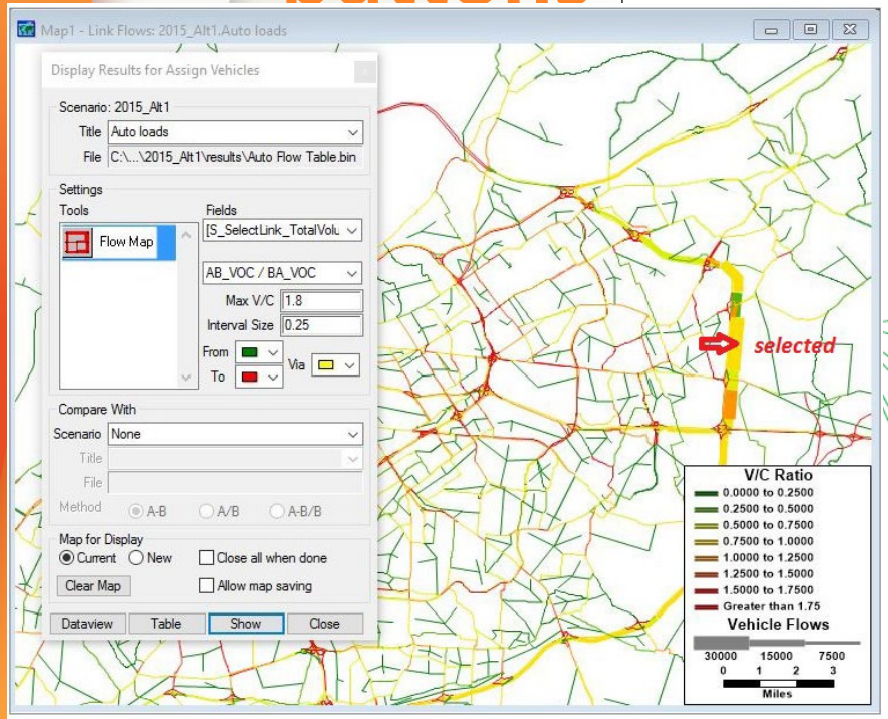
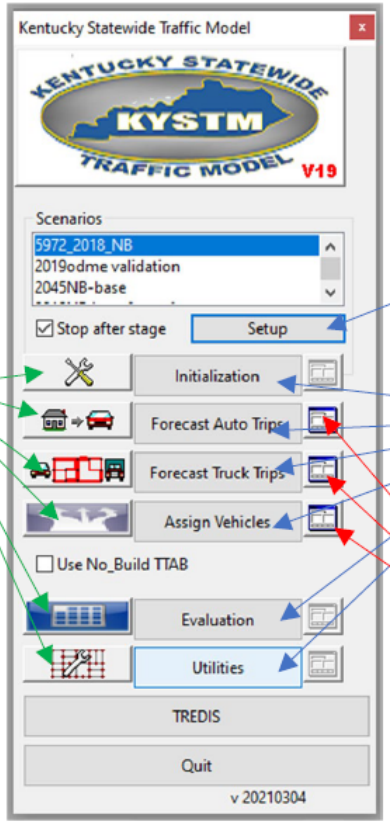


Figure 8-6: Selected Link Loads



Setup Dialog

Model Stage Buttons

Display Buttons

TDOT Department of Transportation

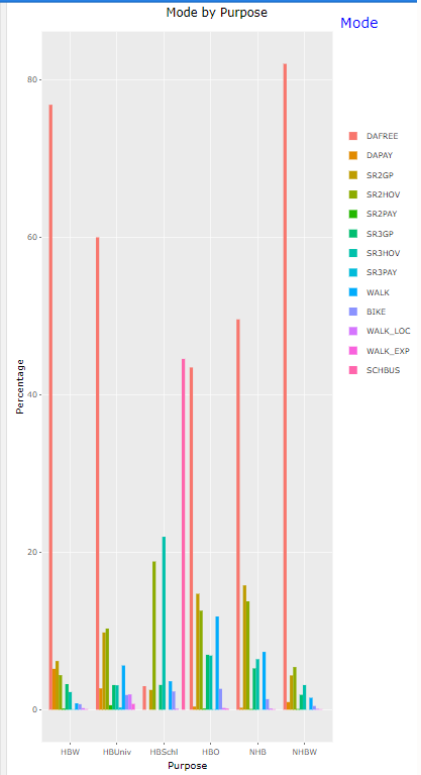
Visualization – Dashboard

TCRPM V.5 Dashboard Alt: 2015R The Corradino Group — 11 October, 2019

MAPS | HH Data | Tour Data | Trip Data | Trip Distribtion Data | Validation - RMSE | ModeChoice

Region: % of Person Trips by Mode and Purpose: Auto occ=1.318

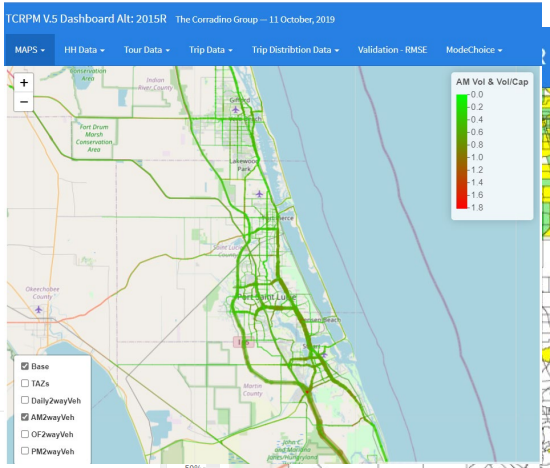
Mode	Percent								
	HBW	HBUniv	HBSchl	HBO	NHB	NHBW	HBW	HBUniv	HBSchl
DAFREE	76.78	59.98	2.99	43.44	49.54	81.98	224,808	10,128	5,08
DAPAY	5.19	2.70	0.00	0.40	0.25	0.97	15,192	456	
SR2GP	6.18	9.80	2.51	14.71	15.78	4.35	18,096	1,656	4,26
SR2HOV	4.38	10.30	18.81	12.57	13.76	5.41	12,836	1,740	31,94
SR2PAY	0.15	0.57	0.00	0.15	0.09	0.09	432	96	
SR3GP	3.25	3.13	3.14	6.97	5.24	1.89	9,528	528	5,34
SR3HOV	2.24	3.10	21.95	6.87	6.41	3.13	6,572	524	37,28
SR3PAY	0.05	0.28	0.01	0.05	0.03	0.02	152	48	2
WALK	0.81	5.61	3.61	11.83	7.34	1.51	2,364	948	6,13
BIKE	0.70	1.87	2.31	2.65	1.34	0.47	2,040	316	3,92
WALK_LOC	0.20	1.94	0.12	0.22	0.14	0.11	592	328	19
WALK_EXP	0.07	0.73	0.01	0.14	0.06	0.05	192	124	2
SCHBUS	0.00	0.00	44.53	0.00	0.00	0.00	0	0	75,61
Sum	100.00	99.99	99.99	100.00	99.98	99.98	292,804	16,892	169,82

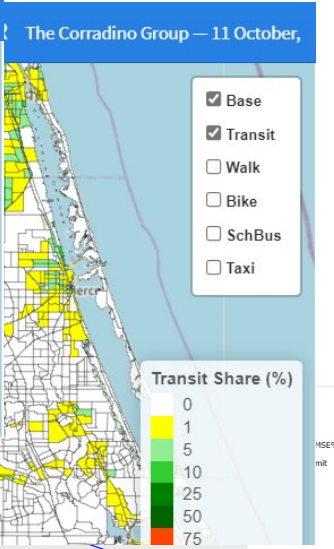


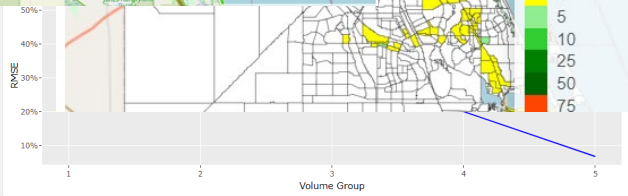
Root-mean-square Error Table

Regionwide RMSE

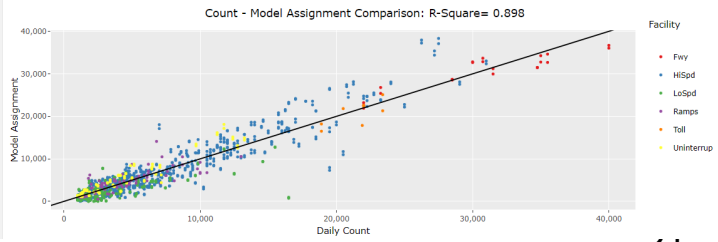
Volume Group	Count	Modeled Volume	N	RMSE%	Volume	RMSE%
1	2,001,432	1,913,603	703	45.82	5,000	55
2	2,088,450	1,907,082	299	32.56	10,000	45
3	2,626,050	2,696,162	191	25.84	20,000	35
4	1,181,300	1,285,559	50	20.12	30,000	27
5	553,000	538,356	16	6.85	40,000	24
Total	8,450,232	8,340,762	1259	33.41	999,999	39







Volume and Count Scatter Plot



TN TDOT Department of Transportation

Visualization – Dashboard

- Bar charts can be used to illustrate the distribution of persons per household, and autos per household by political jurisdiction.
- Stacked bar charts can be used to illustrate the distribution of person trips by purpose and time period.
- Pie charts can be used to display the distribution of trips by trip purpose, trips by time-of-day, or any other vector.
- Grouped bar charts can be used to display trips by purpose and mode.
- Bar charts can be used to display the distribution of household by number of trips.
- Bar charts and line graphs can be used to display the trip length frequency of trips by trip purpose, and political subdivision.
- The highway assignment validation metrics can be displayed as line graphs, along with validation targets.
- Scatter plots can be created showing modeled flows and traffic counts, and goodness-of-fit metrics.
- Thematic maps can be used to show mode shares by TAZ. These plots and those described below can use “OpenStreetmap” as the base map.
- Zonal data, and growth in zonal data between base and future years can be shown as color coded thematic maps. Scripts can be established so the map elements (colors, line widths, and groupings) are the same every time the scripted routines are used.
- Line width maps can be used to show highway flow, and colors can indicate flow versus count or capacity.
- Plots can be made of functional classification for use in quality control.
- Desire line plots can be used to display movements of groups of trips, such as EE, EI, and truck trips.

Data Sources

- "Mobility Data Integration Space" (MDIS): central TDOT repository
- Counts from MS2
- Networks and geography (TSM – Phase 3)
- Transit data and GTFS files from operators
- Land use forecasts (LS-LUM), Phase 3
- Census summaries
- Compile available Tennessee home interview surveys
- Employment from public and commercial sources (interchange with TSM, Phase 3)
- TDOT subscription to Big Data

TN TDOT Department of Transportation

What's Next?

- Confirm/finalize Phase 1 – this study
- Phase 2 – begin model prototype
  - Choose first city (Jackson)
  - Assemble data
  - Develop model + file/attribute names
  - Develop standard reports & visualization
  - Calibrate/validate model
  - Transfer to Tri-Cities (Kingsport, Bristol, Johnson City): validate, test
- Phase 3 – Data Integration
  - Highway only if necessary
  - Specify Advanced Practice integration: data, reports, visualization
  - Two-way integration with TSM
  - Develop and integrate the land use model (LS-LUM)

TN TDOT Department of Transportation

Thank you !

CONTACT:

TDOT:
Mohammad Molla, Ph.D., mohammad.molla@tn.gov

Corradino:
Ken Kaltenbach, PE, kkaltenbach@corradino.com

TN TDOT Department of Transportation