Travel Demand Forecasting and Modeling Chapter

The Travel Demand Forecasting and Modeling process for the Jackson Metropolitan Planning Organization (MPO) was developed in cooperation between the Region 2 Planning Commission (R2PC), which serves as the designated MPO, and the Urban Travel Analysis unit within the Michigan Department of Transportation (MDOT). MDOT was the lead role in the development, calibration, validation, and application of the Travel Demand Forecast Model (TDFM or "model"). R2PC acted as the liaison between members of the public, local agencies, and the Technical Advisory, Policy, and R2PC Executive committees. R2PC and MDOT collaborated on the development schedule of the model, as well as dissemination and distribution of model input and output data for review, comment, and subsequent approval.

Travel Demand Forecasting Models are used to identify and evaluate the capacity demands of a region's Federal-aid roadway system. Identification of roadway capacity deficiencies and analysis of the system as whole, both for the current year through and up to the Horizon Year of the plan, is vital in the development of the Metropolitan Transportation Plan (MTP). A thorough review of the capacity demands of the roadway system is conducted at the regional level and then evaluated with the goals associated with the MTP, along with anticipated financial outlooks. In turn, the assessments, priorities, and overall strategies included in the MTP are used to guide decision-makers in developing the Transportation Improvement Plan (TIP), which is used to program current and upcoming transportation projects, as well as to identify investments of these projects on the Federal-aid roadway system within the Metropolitan Planning Area (MPA). Federal laws and regulations dictate the specific requirements of these plans.

As economic conditions, transportation system trends, financial outlooks, and land use environments change, it is important that the MTP be updated to reflect and account for these changes. As such, the MTP, in accordance to federal laws and regulations, is reevaluated and / or updated every three to five years to reassess the travel demands on the Federal-aid transportation system. Along with the MTP update, the TDFM is also redeveloped or updated to include the changes associated with new MTP. Socio-economic trends and forecasts are also reexamined, which in turn, alters travel behavior and demand on the Federal-aid roadway system within the MPA, and may potentially change overall strategies of the MPO.

The TDFM is a valuable tool used to identify and analyze the capacity demand of the Jackson MPA transportation system. Model results are useful in aiding the decision-making process, which is an important part of the MTP development and implementation. The modeling process and resultant outputs are provided at a regional level and are not necessarily applicable to small-scale geographic levels. The identification and analysis of corridor capacity deficiencies and associated travel projections are intended to serve as the basis for forming decisions regarding system improvement, expansion, or for other roadway capacity changes.

Travel Demand Modeling and Forecasting Process Description:

The Jackson MPO TDFM is currently developed and maintained on a computer platform using the TransCAD Transportation Planning Software Package, as provided by Caliper. The TDFM is a computerized tool used to replicate current roadway conditions and travel demand, as well as to evaluate potential future roadway conditions and travel demand on the road system. The TDFM is a regional-level transportation planning model, focusing on long term transportation planning concerns and regional travel characteristics. Model results provide road link traffic volumes (known in the modeling tool as "traffic flow") for a generalized 24-hour time period. These traffic flows are then compared to the 24-hour capacity allowance of the road link which in turn, is used to calculate the level of relative congestion on the road link.

The typical process used for developing the TDFM involves several inter-related steps. Steps #2 through #5 are the traditional "Four-Step" Trip-end based model structure. The output from each step is used as the input in the following step.

1. Data Development, Collection, and Organization:
   Regional socio-economic data (SE-data) and the transportation system characteristics are collected. This step also includes the development of the model road network and the Travel Analysis Zone (TAZ or "zone") structure.
2. Trip Generation:
   Produces trip origin and destination estimates by trip purpose using land-use, household demographics, employment, and other SE-data characteristics
   - *External Station Estimation*:
     Trips that originate outside of the model and travel into the model, trips that originate inside the model area and travel outside of the model, or trips that originate and travel through the model area are estimated
3. Trip Distribution:
   Trip origin and destination locations are matched based on a "gravity" sub-model function
4. Mode Choice:
   Trips distributed across the model network are broken into modes of travel.
   - *Auto Occupancy*:
     Daily "person" trips are converted to vehicular trips
   - *Time-of-Day Factoring*:
     Daily vehicle trips are further divided into daily time periods (AM, Mid-day, PM, and Night-time periods)
5. Traffic Assignment:
   Trips are assigned a route / path, by a particular mode, and by Time-of-Day to the transportation system

6. Model Validation and Calibration:
   The process by which the model is adjusted (calibrated) to provide simulated results reflective of the current, local observed conditions of the transportation system, within a set of established validation criteria. This occurs throughout each step of the model development process.
7. Model Application / System Analysis:
   A fully calibrated and validated model is used in the development of the MTP, Air Quality conformity analysis, project identification and prioritization, and / or impact analysis

Model Data Development:
There are two main modeling components that are required to be constructed prior to model development:

1. Model Road Network:
   The model road network, which includes various roadway attributes, mostly consists of the Federal-aid road system. "Local" roads are included in the model network to maintain continuity, for connectivity purposes, or if they are regionally significant. If transit is modeled, which it is not for this model, road links that the transit system uses should also be included.
2. Travel Analysis Zone Development:
   Travel Analysis Zones (TAZ or "zone") are geographic divisions of the modeled region. They are developed by grouping areas with similar characteristics, including land-use or human activity. For example, commercial areas are separated to the best extent possible from residential areas. Socio-economic data is aggregated and applied to the various TAZs throughout the model area.

The model road network and the TAZs are mutual. The TAZs are represented on the model road network as a centroid; a "point" on the model road network. The TAZ centroid, referred to as centroid for the remainder of this chapter, is located at the centermost point of activity within the TAZ area. All trips that use the model road network will start or end at a TAZ centroid.

Trips "produced" from or "attracted" to each centroid are connected to the main road system via special model road links called "centroid connectors." Traffic trips are either loaded to the main road network system from the centroid, or are directed from the main road network system to the centroid, via the centroid connectors. Stated another way, these "hypothetical" connections carry the trips produced from and / or attracted to the respective TAZ, represented as a centroid. Special development criteria are used to ensure centroid connectors meet the main road network system at realistic locations. Some of the criteria for connecting to the main road system include connections at driveway cuts, local intersections, or other logical locations.

Base Year Socio-Economic Data Collection and Organization:

Socio-economic data (SE-data) is comprised of demographic and employment information. The SE-data is used to represent activity within the model and is the generator of trips that are modeled across the road network. The SE-datasets were collected and processed for the model base year of 2014, and then forecasted out to the MTP horizon year of 2045. The two datasets that make up the SE-data for this model include the following:

1. Demographic Data:
   The 2010 Decennial Census provided the most detailed level of demographic information. Initially, the population and housing characteristics, obtained from the 2010 Decennial Census, were available at the Census Block level, which are generally smaller than TAZs. However, in order to reflect demographic conditions for the MTP base year, the 2014 American Community Survey (ACS) 5-year datasets were used. Growth factors between the 2014 ACS and 2010 Decennial Census data were applied to the respective level of equivalent geography available for each demographic characteristic.

2. Employment Data:
   As with demographic data, employment for the Jackson MPA was developed to reflect employment as of 2014. The raw form of employment data was derived from a list of businesses residing within the Jackson MPA in 2014. This “master list” of data is purchased by MDOT from two database sources: Claritas (a Nielson Company) and Hoovers (a Dunn-Bradstreet Company). The employment data is geocoded using Geographic Information System (GIS) tools, which can be used in the TDFM. Once geocoded, each business location is combined to the respective TAZ, and divided into various employment sectors.

After the initial collection of SE-data is completed, a thorough review by various stakeholders is conducted. These agencies include the local Economic Development Corporation (EDC), local agencies (Cities, Villages, and Townships), and MPO staff. Once reviewed, changes are incorporated into the employer dataset, and then formally provided to the various MPO committees for additional comments, and then approval. The various Jackson MPO committees approved the use of this data for inclusion into the TDFM in the Fall of 2016.

Socio-Economic Data Collection and Organization for Future Years:
After the base year SE-data is formally approved by the MPO committees, the demographic and employment datasets are forecasted in 10 year increments up to the MTP horizon year of 2045. Using a series of intricate economic and demographic variables as well as incorporating projected changes in alignment with overall trends, a forecast is developed by the Regional Economic Models, Incorporated (REMI) TranSight Model. The initial REMI results, which are provided at the County level, are provided to the Regional Planning Agencies (RPA) and MPOs for review and approval.

During the model development process, these approved growth factors are further stratified so that more detailed and geographic-specific growth factors can be applied to the model TAZs.

As with the MTP base year data, both the demographic and employment datasets are provided to all stakeholders, including the local EDC and local agencies (city, villages, and townships), for review and comment. Once the information is returned and the SE-data is updated, the information is provided to the various MPO committees for further review, and subsequent approval. The various Jackson MPO committees approved the use of this forecasted data for inclusion into the TDFM in the late Spring of 2017.

Transportation System Attribution Collection and Organization:

As stated earlier in this chapter, the model road network consists primarily of the Federal-aid road system within the Jackson MPA. The roadway geographic layer used for the model was obtained from Version 15 of the Michigan Geographic Framework (MGF). The MGF contains much of the needed roadway attributes to differentiate between various roadway classes along with attributes needed in identifying paths of trip travel.

In addition to the roadway attributes available in the MGF, R2PC and MDOT staff reviewed the existing conditions via field verifications and aerial imagery.   In addition to the field review, initial road attribution was provided to the Jackson County Department of Transportation (JCDOT), City of Jackson Engineering Division, and to staff at MDOT – University Region for review and comment. These three road agencies comprise all of the road maintenance agencies within the Jackson MPA.

The following roadway information was provided to these agencies for review:

Facility Attributes

- Federal-Aid status
- Facility Type classification
- Area Type

Other Attributes

- Road Name
- Number of Thru-lanes, by road direction
- Posted Speed Limit (PSL)
- Lane Width: standard or sub-standard
- On-street parking availability: none, one side, or both sides
- Prohibited turns
- Center-Left Turn Lanes (CLTL)

In addition to the aforementioned attributes, modeling staff applied link capacities, Free-Flow Speeds, and validation data (traffic counts), as well as other attribution needed for model operation. Roadway configuration and attribute adjustments are incorporated when operating the model for future year applications.

<u>Travel Analysis Zone Development</u>:

Travel Analysis Zones (TAZ or "zone") are geographic divisions of the model area and provide the structure for housing the SE-data approved by the MPO. As mentioned earlier in this chapter, the TAZ is represented on the model road network as a centroid based on the relative center of activity within each individual TAZ.

A number of guiding principles are used for developing the TAZ structure within the model area. Some of the most critical guidelines for the TAZ structure are as follows:

- TAZ Structure should be compatible with the model road network
- TAZ Structure should be compatible with Census geography (Census Blocks, Tracts, etc.)
- TAZ Structure should be compatible and adhere to political boundaries (city, village, township, county, etc.)
- TAZ Structure should be compatible with the TAZ structure in the Michigan Statewide Passenger Model and the Statewide Freight Model
- TAZ Structure should adhere to natural and man-made boundaries, such as rivers, lakes, parks, railroads, changes in land-use, etc.
- TAZ Structure should accommodate the local transit service routes, to the best extent possible

The 2014 TAZ structure for this model used the TAZ structure from the most recent TDFM, which was used in the 2040 MTP. From there, adjustments to the structure were made based on previous recommendations, changes in socio-economic conditions, and to account for changes in traffic loading to the model road network. There are a total of 581 TAZs, 47 of which are used as External Stations.

These TAZs contain a number of different attributes used to account for differences in land-use, socio-economic, and transportation related variances. Some of the information contained in the TAZs include the following:

- Area Type indicators
  - ➢ Developed from land-use and socio-economic density calculations as well as local agency and MPO staff recommendations
- Demographic totals
  - ➢ Population, Group Quarters, all housing availability, Occupied Housing Units, school-age population proportions (Kindergarten through 12th Grade / K-12), etc.
- Employment totals

    - Broken out into various employment sectors, such as Retail, Industry, Service, etc.
- Transit Accessibility indicator
    - Relative accessibility to transit services and frequency of service
- Future Year Growth Factors
    - Applied to the various demographic and employment attributes

TAZs are an important component for the initial stages of the TDFM development. Later modeling steps will require the use of the information housed within the TAZs to apply and run the respective step. The TAZs will also hold several output information as produced in later modeling steps.

<u>Trip Generation</u>:
Trip Generation is the first step of the four-step TDFM process. In this step, person trip productions and attractions are calculated for each TAZ, for various trip purposes, based on the relative SE-data available for the TAZ. The concept of this stage of model development is to use demographic data to “produce” trips from each TAZ, if applicable, and to use employment data within each TAZ to develop the “attraction” from generated trips. As such, the TDFM uses the concept of productions and attractions to replicate person traveling behavior in the model area.

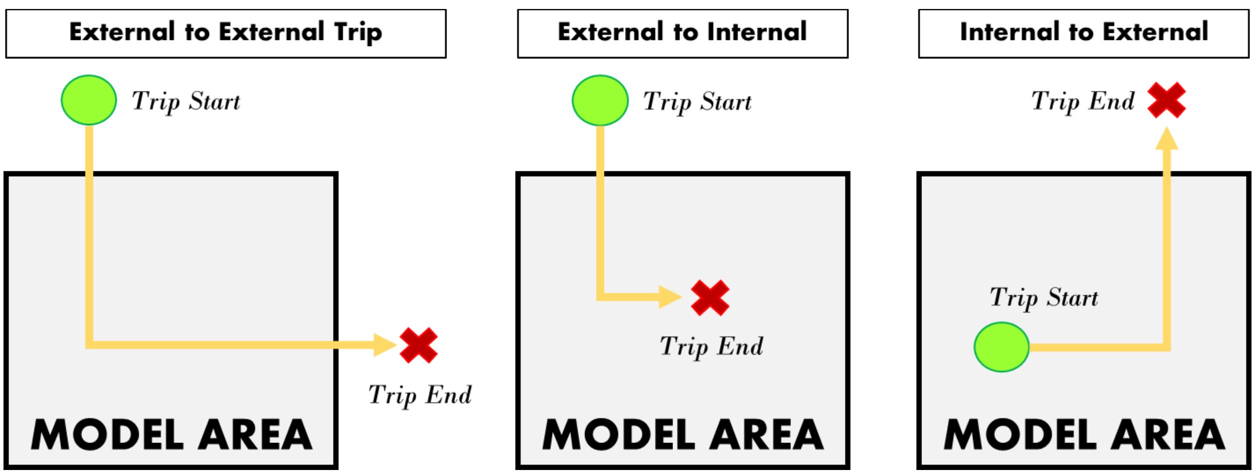
Factors are applied to each TAZ to account for movements where trips are strictly within the area of one TAZ. These factors are often called “intra-zonal” travel factors. In addition, Non-Motorized (NM) mode factors are also included in the calculation of trips produced. NM trips were relatively minor for this model area as it related to the total amount of trips being generated in the model area. As such, NM trips were not distributed, nor assigned to the road network, but simply taken out of the total vehicular trips being produced.

Several Trip Generation methods exist, each having its own strength and weaknesses. In this model, cross-classification methods were used to develop the trip productions. Simply put, cross-classification is used to combine two different data variables, such as household size and household income, and are used to develop the zonal trip productions. Trip attractions for this model used a simple regression equation. Trip productions and attractions were balanced so that the total productions and attractions were equal for the entire model area – each trip produced is attracted somewhere. Cross-classification and regression equations are common modeling structures used to develop trip productions and attractions.

The methods used above apply to person trips that are generated for TAZs that are within the model area. Trips that originate and / or terminate outside of the model area need to be developed and applied to the model. This is accomplished through the external travel development process, which is sometimes referred to as its own step in the modeling process. There are three external trip types that are accounted for within this model:

1. External to Internal (EI):
   - Trips that originate outside of the model area and end at a TAZ within the model
2. Internal to External (IE):
   - Trips that originate from a TAZ within the model area and end somewhere outside of the model
3. External to External (EE):
   - Trips that originate from one external station and end at another external station. Represents "thru" trips

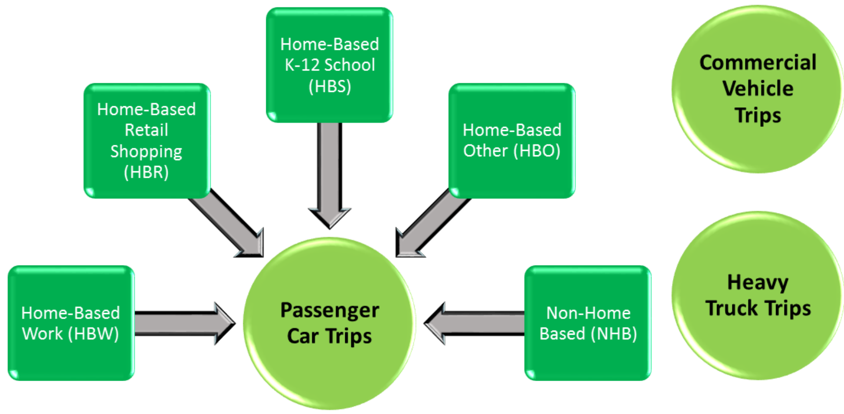
These external trips are also illustrated in the three graphics below:



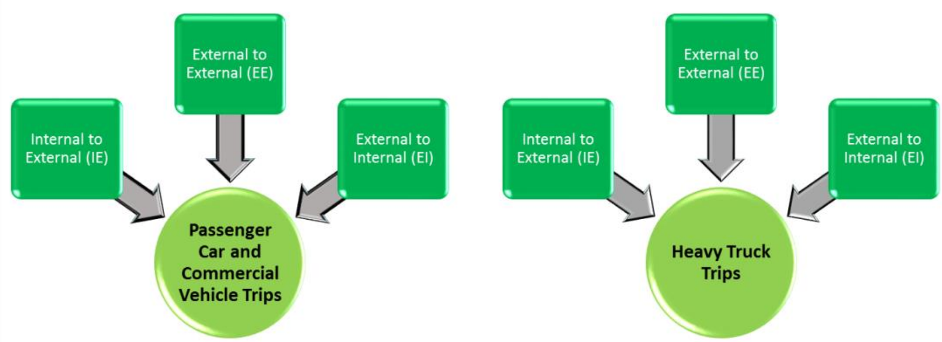
External travel and the type of external travel is originally provided from a larger model, in this case, the Michigan Statewide model. The information from the statewide model provides the amount of trips in total, and the percentage of those trips that are EE trips. The information is then further processed to develop an estimate of the number of EI and IE trips. The external trip information and calculations are already in vehicular format, and do not need to go through an auto-occupancy assignment routine.

Trip generation and external travel estimation is made up of various trip types, based on the primary purpose of the trip being made. Each trip type has unique production and attraction rates, which are based on SE-data and survey information. Trip purposes for this model, and the vehicle modes they represent, are provided in the following charts:

Internal to Internal Trips Purposes



External Trips



Trip purposes are classified for internal to internal passenger car trips only, while internal to internal commercial vehicle and heave truck trips do not have trip purpose categories associated with them. As such, they may called "mode trips" or "trips by mode" for clarity purposes. For external travel, trip purpose is not assigned based on the trip type, but assigned based on the overall movement of trip (IE, EI, or EE). This is applied to passenger cars and commercial vehicles, as well as heavy truck trip modes.

The trip generation and external travel estimation components, applications, factors, and parameters, were developed based on the most recent survey data available – the *2004-2005 Comprehensive Household Travel Data Collection Program / MI Travel Counts I* program and the *Urban Model Improvement Program (UMIP)*, both of which were conducted by MDOT.

The outputs of this step are a balanced trip table, which is used as an input into the next step of the traditional four-step TDFM, Trip Distribution.

Trip Distribution:

The second step of the four-step TDFM process is called Trip Distribution. In this step, the balanced trip table from the Trip Generation stage (balanced productions and attractions, by trip purpose) along with the model road network, are used to match trip productions and trip attractions from TAZ to TAZ, which in turn, creates "trips" along the model road network. Various methods are used in this step to best replicate the potential travel along the model road network and to show a reasonable interaction between one TAZ to another TAZ.

The following methods used in Trip Distribution for this TDFM are listed in the table below:

Impedance Factors

- Also known as "travel time"
- Establishes an amount of travel time between each TAZ pair by traversing and analyzing all available routes (also known as "paths")
- The outcome of this is to establish a "shortest path" between TAZ pairs

Gravity Model

- Common method for travel modeling applications - "a model within a model"
- Uses "realitive attractiveness" and impedance, both of which are conflicting influences, to calculate and estimate the amount trip interaction between any TAZ pairings
  - "Relative attractiveness" may include the geographic proximity of the matched TAZs, the number of employees in the TAZ of attraction, and travel time

Friction Factors

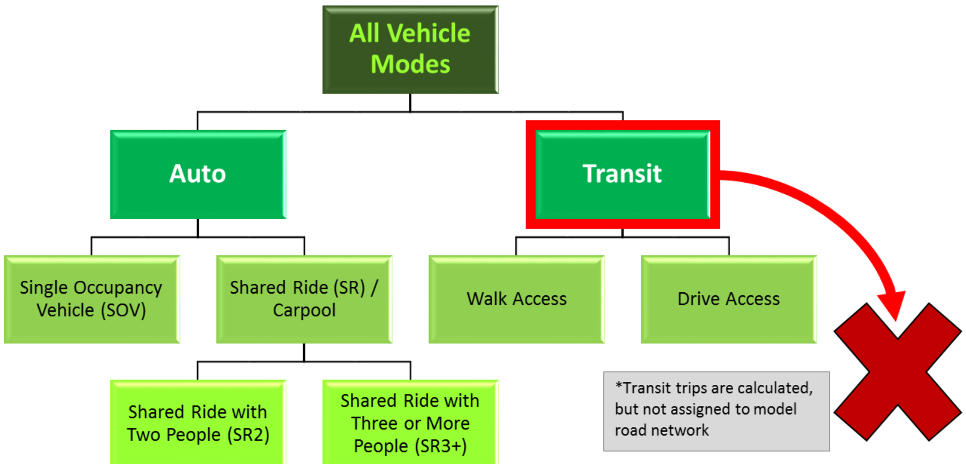
- Represents "perceived" time
- Used to help balance conflicting influences of attractiveness and impedance
- Result is to replicate "observed" travel time distributions

The gravity model is calibrated using successive friction factor adjustments to produce model travel time trip lengths that are consistent with "observed" travel time. Each trip purpose will have a unique travel time trip length and thus, each trip purpose and trip mode must be manually calibrated to ensure consistency with observed travel time data.

The results of the Trip Distribution step is a matrix that provides a breakdown of relative TAZ to TAZ interactions by the various trip purposes and trip modes. The results of Trip Distribution are used for the next step, Mode Choice.

Mode Choice:

Mode Choice is the third step of the four-step TDFM process. At this stage in model development, all trip data, with the exception of external travel data, are in "person-trip" format. As such, the trips must be allocated to distinct vehicular modes, which are auto and transit trips. The chart below provides a brief overview of the types of vehicle modes that are used to allocate the person-trips for this model:



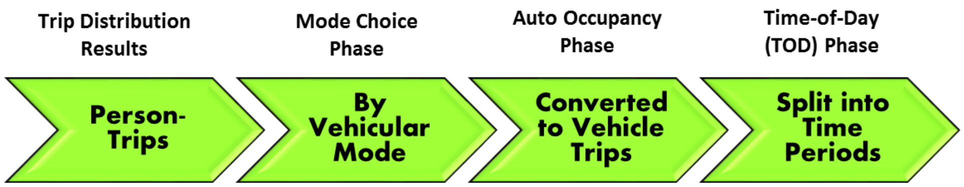
The above chart represents a "Nested Logit Structure," which is a common method in TDFM applications for combining trip results into various vehicular modes. Selecting the appropriate vehicle mode relies on two key factors:

1. Trip purpose (HBW, HBR, NHB, etc.)
2. Access to transit (via a TAZ-level transit service categorization)

Transit trips, albeit a vehicle mode, are not assigned to the TDFM road network due to the complex nature of the trip interactions and socio-economic conditions related with transit ridership. The TDFM used for MTP purposes is to analyze regional transportation patterns, and not necessarily micro-level or individual trip characteristics.

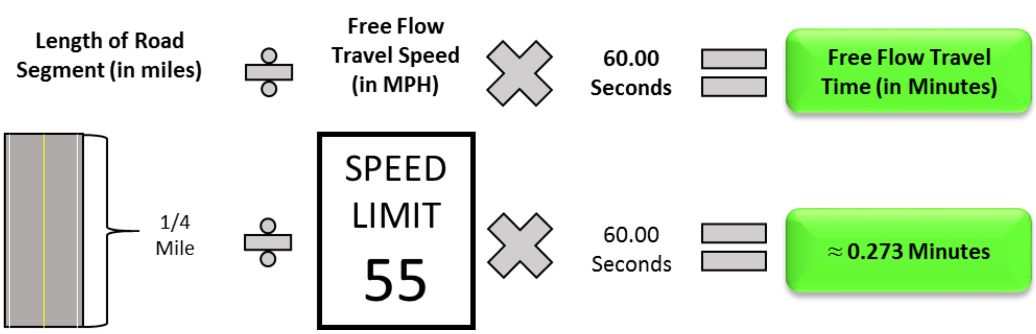
As such, mode choice for this model used a "simplified" approach where transit trips are initially calculated prior to auto trips, and then subtracted from the total vehicular trips. The resulting trip total is then broken into various auto shares: Single Occupancy Vehicles (SOV), Shared Rides with two people (SR2), and Shared Rides with three or more people (SR3+). Shared Rides may alternatively be referred to as "carpooling" or "High Occupancy Vehicles (HOV)." The final results of the mode choice component is a series of person-trip tables by vehicular mode and trip purpose for each TAZ Origin-Destination pair.

Auto Occupancy and Time-of-Day (TOD), which can be classified as subsets of the Mode Choice step, converts the person trips that are calculated from the mode choice stage into vehicle trips and separates these vehicle mode trips into various TOD periods. The conversion into vehicle trips and TOD are based on auto-occupancy and TOD modeling factors respectively. The finalized product from the Mode Choice step is a number of tables representing vehicle mode trip categories by time periods. The illustration below shows a simplified view of this process:



Mode Choice, along with auto occupancy and Time-of-Day modeling, factors, and parameters are developed based on data provided in part by the *2004-2005 Comprehensive Household Travel Data Collection Program / MI Travel Counts I* program and the *Urban Model Improvement Program (UMIP)*, both of which were conducted by MDOT.

<u>Traffic Assignment</u>:
Traffic (or “Trip”) Assignment is the final step in the traditional four-step TDFM process. In this step, trips (i.e. vehicle-based trips, by vehicle mode, and by TOD period) are assigned to a “route” on the model road network between each TAZ origin and TAZ destination. Traffic assignment uses the underlying principle of a TDFM that trip makers will use the “best” route, based on travel time. Travel time is calculated as a function of the link distance and speed, and is one of the determining factors when assigning trips to the model road network. It is developed using the following equation:



The road link volume and capacity of the road link are included during the assignment process. For example: a roadway that is reaching, or has reached its maximum capacity will result in reduced travel time. As such, the assignment routine will include these time reductions when choosing the “best” path. If the delay is significant, an alternative road may be used to accommodate that traffic.

Though traffic assignment, at first glance, may appear as the most straight-forward step of the four steps, it is made up of various procedures that are inherent of a TDFM and requires careful consideration of the methods chosen to assign the trips to the model road network. Different methods and supporting functions will produce very different assignment results.

As such, the traffic assignment method used for this model was the "User Equilibrium (UE)" algorithm, which is commonly used in TDFMs. When selecting the "best" route, UE assumes that trip makers will consider all available travel paths between an origin and destination that have equal travel time. As a result, altering paths will not save travel time. The algorithm attempts to optimize the travel time between all possible paths, reflecting the effects of system congestion. TDFMs used for MTP purposes do not include human-related factors when assigning trips, such as road geometrics (hills, tight curves, etc.), road condition, and other considerations.

The final product of Traffic Assignment is a series of vehicle-trip (modeled traffic volume or "traffic flow") tables, by vehicular mode, and separated into TOD, for each model road link within the model road network. The "assigned" link traffic volumes are then compared with "observed" traffic data (i.e. traffic counts) as part of the model calibration, validation, and reasonability review.

Model Base Year Validation and Calibration:
To ensure that the TDFM reflects observed base year conditions, a number of quality checks were implemented. The most important, and ultimate goal, for the TDFM is to have base year assigned volumes within a reasonable level of traffic counts used for the model base year. Thus, traffic counts on the Federal-aid road system from all respective maintaining road agencies within the MPO is crucial. Without this information, the effectiveness of the model is limited. The local road agencies within the Jackson MPO provided traffic count data to MDOT for use in this TDFM.

Model "calibration" is a term that means various modeling parameters and input or output data are adjusted to replicate observed data as closely as possible, or within pre-defined thresholds. In some cases, such as future year analysis, calibration is used to provide reasonable and realistic results, which is not always straightforward if there are large changes to the road network and / or SE-data throughout the model area. Model "validation" is simply the comparison of the calibrated model to the observed data. Several calibration adjustments may be performed to meet pre-defined validation targets.

If issues are discovered during model application and validation, then it is necessary to return to a previous step in the modeling process to calibrate the input and / or output data. Model calibration and validation are applied for each step of the TDFM development process and for the entire model system, preferably using observed data not used for model estimation. In the chart below, a brief list of common calibration tasks are provided, which are used to meet pre-defined validation targets:

	TDFM Step:	Common Calibration Tasks:	Example Validation Tests:
	Data Collection. Organization, & Development	-SE-data is reflective of originating sources, local agency comments, and approved by MPO committees, via manual adjustments to raw data -Aligning road network with TAZ structure -Constructing TAZ layer to best reflect transit "accessibility" -Identifing and building special generators within model area	-Average houshold size = ± 5.0% of Census / ACS calculations -Combined TAZ population totals are consistent with parent Census Tract totals -Model-wide employment totals are consistent with BEA and BLS estimates -Average TAZ size (in square miles), population / employment densities, etc. match UMIP targets, or within reasonable ranges, by varying land-use categories
1	Trip Generation & External Travel	-Adjusting detailed demographic data to most appropriately reflect overall TAZ characteristics -Non-Motorized factors are appropriately assinged to each trip purpose -Adjusting External to External travel patterns to reflect realistic travel paths	-Trip productions and attractions are balanced for each trip purpose, model-wide -Trip rates meet UMIP, NCHRP, or other reference sources & standards -EE + EI + IE trips at a sampled external station equal total trip movements as provided by statewide model and traffic counts (if available)
2	Trip Distribution	-Re-drawing or re-connecting network links to create conintuous connectivity -Modificaiton of terminal times -Adjustment of Gravity Model parameters to reflect average observed trip lengths, for each trip purpose, based on MPO size (in square miles and SE-data characteristics)	-Using TransCAD testing applications; verify shortest path between TAZ pairs - random sampling -Average trip lengths, for each trip purpose and mode, are consistent with MTC I survey data -Intra-zonal trips meet UMIP standards for home and non-home based trips
3	Mode Choice, Auto Occupancy, & TOD	-*Simplified Mode Choice is unique to each individual MPO area* and thus, inputs may need to be adjusted to balance meeting realistic targets, stakeholder comments, and survey data (if available) -Most calibration for Mode Choice is done by updating data in earlier steps	-Proprtion of Auto modes by trip purposes are similar with surveyed data & UMIP -Total calculated transit trips are consistent with transit survey data and / or National Transit Database ridership information -TOD auto mode trip purpose percentages are consistent with UMIP or surveyed data
4	Traffic Assignment	-Modification of various network-level capacity values to reflect realistic conditions -Free-flow travel speed adjustments by Facility and Area Types, as well as by various Volume Groups -Adjustment of α & β coefficients to reflect observed traffic diversion thresholds -Relocating or removing Centroid Connectors to / from main model network	-Modeled Vehicle Miles Traveled (VMT) is within various, predefined thresholds of observed VMT by Facility Type, Area Type, & Volume Group -Modeled volumes are equivalent to available traffic counts, and are within recommended targets for Facility Type, Area Type, & Volume Group categories -Results are realistic (volumes increase at high-volume intersections, etc.)

<u>Application of the Validated TDFM</u>:

Once a model is fully calibrated and validated for the base year, it can be used to forecast traffic patterns for future years. Approved SE-data and road network changes, via the Transportation Improvement Plan (TIP) and local support, can be used as substitutions into the various modeling components to produce future year results. The assumption is that model formulas and relations developed for the base year model structure remain constant over time, as to provide an unbiased forecast.

Generally, there are three distinct "testing" scenarios that are developed for the MTP, and include the following:

Base Year / Horizon Year, No Build

- Referred to as the "validated" model
- Base year uses 2014 ("existing") SE-data to generate traffic volumes on 2014 road network
- Horizon year uses 2045 ("projected") SE-data to generate traffic volumes on 2014 road network
- Used to identify current or anticipated roadway congestion and / or capacity deficiencies
- Both are required first before running the remaining two scenarios

Base Year / Horizon Year, Existing Plus Committed (E+C)

- May also be referred to as "Base Year Plus TIP Network"
- Base Year uses 2014 SE-data to generate traffic volumes on 2014 road network with committed road projects included
- Horizon year uses 2045 SE-data to generate traffic volumes on 2014 road network with committed road projects included
- Used to identify if TIP projects initially alleviate or resolve roadway congestion and / or capacity deficiencies, if any are identified in the No Build scenario
- If determined that additional capacity projects are needed, move to next model scenario

Horizon Year, Improve and Expand (IE) Build Scenarios

- Evaluate horizon year 2045 only
- Projects are tested and selected for alleviating base year 2014, and / or horizon year 2045 congestion and road capacity deficiencies (Improve and Expand projects)
- Horizon year uses 2045 SE-data to generate traffic volumes on 2014 road network with committed road projects, and additional "test" projects not listed in TIP ("2045 Network")
- Successive testing is done until "final" build scenario and projects are selected by MPO
- Can also be used to evaluate traffic responses as a result of roadway capacity reduction projects (e.g."road diets")

In addition to various road network changes to test, a MPO may elect to use future land-use modeling software tools to include in the TDFM for evaluating the potential traffic impacts as it relates to socio-economic and land-use changes. The Jackson MPO did not pursue this type of testing.

Once the base year and horizon year traffic outlooks have been evaluated, the MPO reviews the traffic impacts of various road projects included in the TIP, for both the base and horizon years. The MPO may then begin testing additional projects that are not yet included in the TIP. If determined that additional projects should be tested, then successive rounds of testing and review are pursued until the results are in line with the goals of the MPO. The Jackson MPO elected to not pursue any further testing beyond the Base Year / Horizon Year E+C scenario as a result of no current or expected roadway capacity deficiencies and limited congested areas, over a 24-hour period. The model results are discussed in more detail in the *Roadway Transportation System Deficiencies and Recommended Projects* chapter of the MTP.

The model can be used for additional transportation system analysis outside of the MTP process, which include, but not limited, to the following:

- Impact analysis for planned roadway improvements, expansions, or other capacity-altering alternatives
- Individual links can be analyzed to determine which TAZs are contributing to traffic flow on the particular link. Can be shown as a percentage breakdown or by raw volumes
  - Can be referred to as the "service area" of the selected link
- New accessibility, such as a proposed bridge, can be tested to identify traffic flows to and from the new roadway and for adjacent roadway links
  - Limiting factors, such as closure of a bridge, or tolling, can also be tested
- Land-use and economic changes, such as a new retail establishment or expansion of an existing manufacturing plant, can be applied to the model. Base year and horizon year traffic flows can be evaluated as a result of these potential changes
- Road closure, road restriction, and / or detour evaluation studies can be conducted to determine the effects of closing a roadway, and / or restricting capacity, and detouring traffic during construction activities
  - Useful for construction management
  - Also referred to as "Workzone testing"