

Travel Demand Forecasting User Guide

A Supplement to the Regional Transitway Guidelines

Metropolitan Council

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This document supplements the Project Development, Leadership, and Oversight discussion of Travel Demand Forecasting in the Regional Transitway Guidelines by providing additional information for topics discussed in the Guidelines.

1. INTRODUCTION

Travel demand modeling is an essential part of transportation planning for transitway investments. It allows project planners to identify and analyze travel demand markets and produces ridership estimates. Estimates of ridership are important throughout the transitway development process for project justification; in early planning stages for alternative analysis and selection; and in later planning stages for service planning, facility needs assessment, and future revenue projections. Realistic and defensible travel demand forecasts are needed at every stage of transitway planning and project development.

2. LEAD AGENCIES AND RESPONSIBILITIES

The Metropolitan Council, acting in its role as the federally recognized MPO, is responsible for ensuring high quality, consistent and defensible travel demand forecasting is completed for all transportation projects in the Twin Cities region, including transitway projects. However, the Metropolitan Council itself does not typically perform the travel demand forecasting work, and it may or may not be the organization leading the development effort for a particular transportation project (lead organization). For these reasons, local partner agencies and the consulting community also bear responsibility in developing the region's travel demand forecasts.

For every project, the Metropolitan Council is responsible for maintenance and development of the Regional Travel Demand Forecast Model (RTDFM) and for the development of forecast socio-economic data. In cases where the Metropolitan Council is a project's lead organization, it is also responsible for directing travel demand forecasting and other work being performed by one or more consulting firms.

In cases where a local partner is the lead organization, the local partner is responsible for directing work being performed by one or more consulting firms and also for involving Metropolitan Council forecasting staff in a cooperative review during all phases of travel demand forecasting. At a minimum, this cooperative review should take place during the following phases of a study:

- Development of a proposed scope of work
- Review of proposed travel demand forecasting methodology prior to beginning any modeling work
- Review of model validation prior to proceeding with forecasts
- Review of no-build or baseline input assumptions
- Review of draft forecasts prior to their presentation to project stakeholders, including policy makers and the general public.

2.1. FORECASTING GOALS AND ALLOCATION OF EFFORT

Travel demand forecasting should be used judiciously and may serve different purposes throughout the project development process. The goal of travel demand forecasting is to develop results that are logical, sensible, and reflective of key differences between alternatives; a perfect number will not be produced by travel demand forecasting. The development of these kinds of high quality, defensible forecasts takes time and effort.

Independent of the phase of project development, national and local experience suggests that a third to half of an overall forecasting effort is typically devoted to building and validating the base model before running or analyzing any alternatives. Furthermore, these experiences suggest that travel demand forecasting makes up a quarter to half of a particular study's overall effort. This will vary depending on the length of the corridor and the overall complexity of the project. Lead organizations and consultants should be mindful of these guidelines when scoping forecasting tasks for a study.

During feasibility studies and early phases of alternatives analyses, travel demand forecasting should be used to identify and describe the travel markets present in a potential transitway corridor and to produce high-level transit ridership demand data for proposed alternatives. A screening evaluation should be performed based on factors other than travel demand to limit the number of alternatives requiring travel demand forecast modeling. In addition, similar alternatives should be grouped to minimized potential distractions caused by operational variations that are not yet significant during this phase of project development. These approaches will allow the forecasting team to keep the development of a solid base model and identification of travel demand markets top priorities.

In later stages of project development, the purpose of travel demand forecasting is to produce results that are un-biased across the alternatives under consideration. At this point in the process, all of the ridership markets on each alternative under consideration should be understood and correctly modeled. Modeling process and coding should be consistent across alternatives.

2.2. TRAVEL DEMAND FORECASTING MODEL OPTIONS

Several potential travel demand forecasting approaches might apply to transit projects in the Twin Cities depending on a project's stage of project development or scale of project. In general, these approaches fall into two categories: the RTDFM or rule-based market analysis tools.

The RTDFM is a multi-modal transportation forecasting model maintained in the Twin Cities region by the Metropolitan Council. Its results are based on use of socio-economic data allocated throughout the region to traffic analysis zones (TAZs) and a classic, four-step travel demand modeling process. The modeling process generates trips for each TAZ based on forecasted demographic and economic variables. The modes of travel available in the zone, also called generalized accessibility, are used to calculate trip destination by purpose. Generalized cost (including travel time) is used to calculate the mode of each trip. Transit trips are then assigned on the regional network. The RTDFM is a series of sub-models which reflects complex interactions between travel time, accessibility, and cost across different trip purposes and market segmentations (e.g. income, auto ownership).

Rule-based market analysis tools are based on allocation of portions of existing markets based on base market data (e.g. Census Transportation Planning Package (CTTP) or Longitudinal Employer-Household Dynamics (LEHD) data for the work market) and selected characteristics of the transit system. Several examples of rule-based market analysis tools in use today are include:

- **Aggregate Rail Ridership Forecasting (ARRF) II Model:** A rule-based model which applies a series of expected rail shares and adjustments for service characteristics to 2000 Census for Transportation Planning Package (CTTP) Data. It was developed by FTA to estimate rail ridership for cities without existing rail systems, and is used as a secondary check for New Starts forecasts.

- Metro Transit Park-and-Ride Model: Metro Transit currently uses a rule-based model for forecasting park-and-ride demand. A series of factors (downtown workers, mode splits, etc.) developed from longitudinal employer-household dynamics (LEHD) and surveyed parking origin data are applied to forecast population to develop future demand.
- Transit Boardings Estimation and Simulation (TBEST) Tool: The State of Florida has developed a comprehensive transit analysis and ridership forecasting model that is capable of simulating travel demand at the individual stop level while accounting for network connectivity, spatial and temporal accessibility, time-of-day variations, and route/stop competition and complementary effects.

Model selection is discussed in the next section. Selection of any given model approach should be made with an awareness of its strengths and limitations as well as an understanding of the inherent uncertainty involved with any modeling effort.

2.3. FORECASTING PROCESS

This section of the document focuses on several key elements of the forecasting process; the goal of each forecast refinement, the selection of a model and refinement of methodology, validation of the base model, and documentation of base and future year results. This discussion is not intended to be a technical manual of forecasting practice, but to summarize key issues underlying the needed scope and complexity of the forecasting process.

2.3.1. Iterative Nature

Forecasts evolve over time, along with the rest of the project during the development process, as new data becomes available. Model inputs to be refined at each step include both networks and zonal data (though the socio-economic data used for forecasts needs to be the approved Metropolitan Council TAZ data for base forecasts). However, each step should use the same model (overall process, set of programs, linkage to survey data, etc.). At each refinement, ridership forecast numbers may increase or decrease. The goal of each refinement is to produce the highest quality forecasts based on known alignment data and the latest planning assumptions. It should not be to match or exceed the result of previous forecasting effort.

2.3.2. Model Selection

A primary consideration in selecting the travel demand forecasting approach is the type of funding for which the lead organization wants the project to be eligible. The largest sources of federal funding for transit capital projects are the New Starts, Small Starts, and Very Small Starts programs. Forecasting for projects that may become New Starts projects should use the RTDFM and be done in cooperation with Metropolitan Council forecasting staff as noted above.

While other and simpler methods of forecasting ridership exist for Small Starts, Very Small Starts, and non-New Starts projects, use of the RTDFM is recommended as a starting point for all projects. The RTDFM is the only forecasting methodology available with:

- The ability to reflect all geographic markets, including non-work markets, for a corridor
- Sensitivity to various scenarios of future development

- Sensitivity to routing, access, and operating characteristics of the transit and other transportation systems
- The ability to extend analysis beyond basic total ridership, including analyzing ridership by station/stop and to follow a trip from origin to destination, and the ability to measure trip-based user benefits.

Another benefit resulting from use of the RTDFM on all transit projects is its consistent use creates opportunity for comparison of travel demand results among different corridors in the region.

Use of the RTDFM for Small Starts, Very Small Starts, and non-New Starts projects may be more flexible in methodology than its use for New Starts projects. In particular, New Starts forecasting conditions required to ensure national comparability – such development of a Baseline Alternative and the requirement for a constant trip table – are not required for projects being developed and delivered outside the New Starts/Small Starts process. However, a lead organization should be aware of and acknowledge the financial and political risks created using these approaches should the project evolve into a New Starts project. Another opportunity for these kinds of projects is that when only near-term forecasts are required, it may be acceptable to use trip tables derived from transit surveys rather than the full modeling process.

There are cases where the RTDFM may not be the best analysis tool and rule-based market analyses should be performed and documented. But when using rule-based models, it should be recognized that few are accepted by FTA for use in New or Small Starts projects, and those that are tend to be as data-intensive and complex as four-step and activity-based regional forecast models. Examples of projects where a rule-based market analysis may be appropriate are:

- Park-and-ride facility planning - the Council's Park and Ride Planning Model may be a more appropriate tool
- Local route planning applications where stop spacing is smaller than the TAZ size in the RTDFM
- Projects where service changes are not anticipated to generate new ridership and benefits are intended to be estimated for existing users only

2.3.3. Development of Model Assumptions and Modifications

Input data used for forecasting should be based on latest planning assumptions. Land use and socio-economic forecasts for the horizon year should be based on approved Metropolitan Council municipal totals and consistent with local comprehensive plans. Highway and transit networks should be consistent with the adopted TPP. Potential changes in approved socio-economic data or TPP amendments should be discussed with Metropolitan Council staff. Service planning assumptions should be reviewed by appropriate transit agencies and Metropolitan Council staff.

It is often worthwhile, especially when there is significant uncertainty in long-range socio-economic forecasts or local transportation improvements, to perform sensitivity analysis on key inputs. This increases the number of model runs required, but can provide insights to the reasons for resulting ridership forecasts and their reasonableness.

For corridor-level analysis, expansion of the model zone system and/or sub-area zone splits are often warranted. Application of these, and other modifications to the RTDFM structure or parameters should be done with care and with consultation with Council staff.

2.3.4. Model Validation

Forecasting results produced using the RTDFM and rule-based market analyses both require validation against observed data as model results are only meaningful in the context of observed data. The RTDFM is calibrated and validated at a regional system level. Before it can be used to produce valid and credible corridor transit forecasts, the model's reasonableness in the base year needs to be reviewed and documented in the corridor study area. This is to check for problems with the model itself, which would not be visible on a regional scale, and to check for coding errors in input files. The agency and the person or firm performing the validation should review and analyze data and results prior to submitting them to the Metropolitan Council for review. Specifically, counter-intuitive results should be explained in writing. This analysis should be documented and submitted along with the data and results.

Validation should include, but is not limited to, comparison of the modeled and observed:

- Highway and transit travel times and speeds
- Productions and attractions and person trip tables by district and by trip purpose
- Assignment of transit trip tables from survey data compared to observed boarding data.
- Base year transit assignment results by:
 - Time of day
 - Line for routes within the corridor
 - Mode of access by route and/or station
 - Type of service (express, local, LRT, BRT, etc.)

Content of validation for non-RTDFM methods may differ from that described above, although a linkage to observed data remains critical. Validation should be performed in consultation with Metropolitan Council forecasting staff.

2.3.5. Forecast Development

While validation of the model in the base year is a necessary step toward ensuring that the model is reasonably reflecting future conditions, it is not a guarantee. The complexity of the modeling process (and, indeed, the future itself) can make the determination of forecast reasonableness and the cause of any errors difficult. A systematic approach to developing the base future year (no build or baseline) and alternative model runs is recommended.

Differences between forecasts from one step in the process and the next, or between build alternatives, should be traceable to changes in input assumptions and be sensible. A stepped series of forecasts building up from the base year to the full future forecast is a systematic approach that is often useful to understand the dynamics of the input assumptions and their impact on the final forecast. The steps in a stepped approach could be as illustrated in Figure 1:

Figure 1 – Build-up Forecast

	Step 1- (Validation Run)	Step 2	Step 3	Step 4	Step 5 (NoBuild)	Step 6 (New Starts Baseline)	Step 7 (Build)
Base Year Forecast							
Future Year Development							
Future Year Parking Costs							
Future Year Highway Congestion							
Future Year Transit System (no transitway improvement)							
Other Corridor Improvements							
Transitway Improvement							

While this approach moderately increases the number of forecast model runs required, it is a worthwhile investment of time and resources that will ensure all transitway projects in the Twin Cities are developed based on credible and defensible travel demand forecasts. The first forecast and the last three forecasts are typically produced in any normal study process.

2.3.6. Forecast Documentation

Forecast methodology (including zonal data changes and transitway operating parameters), validation and results should be fully documented. Draft documentation of methodology and validation should be submitted to Metropolitan Council forecasting staff before any official model runs are done. This submittal should include electronic copies of the transit networks (validated base and build networks).

During transit forecast development, the following should be analyzed, documented in writing, and provided to Metropolitan Council forecasting staff:

- Changes to base zonal data or networks (both highway and transit)
- Specified vs. calculated headways and travel times
- Modeled person trips by purpose, by district, by time of day, and by mode
- Modeled district-to-district transit trips
- Modeled boardings in the corridor by mode, by time of day, by route or group of routes
- Modeled transfers

- Modeled screen-line volumes
- Modeled passenger loads by route, mode, and time-of-day and peak loads
- Forecast ridership by access and egress modes by route and by station
- Passenger and vehicle hours/miles of service

The agency and the person or firm producing the forecasts should review and analyze data and results prior to submitting them to the Metropolitan Council for review. Specifically, counter-intuitive results should be explained in writing. This analysis should be documented and submitted along with the data and results. When forecasting is complete, electronic copies of the model developed and all data should be sent to the Metropolitan Council for preservation.

2.4. PRESENTATION OF RESULTS

All travel demand forecasts are derived from models of future conditions based on uncertain assumptions and limited base data. All forecasts contain risk and uncertainty. It is often appropriate to clearly communicate this uncertainty when presenting results. If the forecast involves multiple alternatives, communication of uncertainty may help in evaluating the significance of differences in results between alternatives.

No performance measure, including ridership, can be fully evaluated without the presence of a no-build alternative for comparison. The no-build alternative should be forecasted using the same validated model or alternate methodology as the comparison alternative (for FTA New Starts projects, comparison to the New Starts Baseline is also required).

2.4.1. Transitway Ridership Definition

It is useful when comparing different potential transitways in the region to have a set of metrics with consistent definitions. In particular, *ridership* can be a difficult metric to apply in different settings, given the potential complexity of connecting, parallel, and feeder service and the differing route structures of LRT, Commuter Rail, and BRT service.

For the purposes of regional comparison, ridership should be defined as:

LRT: Rides taken using the LRT service

Commuter Rail: Rides taken using the Commuter Rail service

BRT: Rides taken using the BRT station-to-station services

Rides taken on local or express services that utilize the a defined transitway runningway for at least 50 percent of the route and use at least one non-downtown transitway station

Care should be taken to count (one-way) rides, to avoid double-counting transfers, and to exclude any rides provided on transitway feeder services that do not travel on the transitway from the transitway ridership total. Express bus ridership that does not primarily travel on the transitway runningway or does not serve at least one non-downtown station on the transitway should not be counted. Ridership on bus routes that are primarily feeder service or on parallel routes that do not use the transitway

runningway should not be counted. Rides on local service using an Arterial BRT runningway should be counted.

2.4.2. Other Performance Measures

No single performance measure can fully represent the benefits of transitway service or serve as a basis for comparison between corridors or alternatives in all cases. Differing performance measures may be warranted for different types of projects (a new transitway vs. a new station). Other potential measures that should be evaluated are new transit riders, existing riders that benefit from transitway, total corridor riders, passenger miles per mile, total linked and unlinked trips, transit travel time saved and total user benefits.