Identifying Potential Opportunities for Model Improvement

Task Order 15.2, Draft Report 1

prepared for

Metropolitan Washington Council of Governments/ National Capital Region Transportation Planning Board

prepared by

Cambridge Systematics, Inc.

August 27, 2015

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1.0 Background

The National Capital Region Transportation Planning Board (TPB) is the Metropolitan Planning Organization (MPO) for the Washington, D.C. metropolitan area and one of several policy boards that meet at the Metropolitan Washington Council of Governments (COG). TPB is staffed by COG's Department of Transportation Planning (DTP). Cambridge Systematics (CS) has been asked by the COG/TPB staff to develop a multi-year, strategic plan for the development of its regional travel demand modeling process. This effort is being completed under Task Order No. 2 of Fiscal Year 2015 (Task Order 15.2) of COG Contract No. 14-056, "Assistance with the development and application of the MWCOG/NCRTPB travel demand model." This consultant-assistance project was started in 2005 and is now in its tenth year. A consultant may hold the contract for no more than three years before the contract must be rebid.

This report is the first of three developed under Task Order 15.2, and focuses on identifying potential opportunities for improvement to the current COG/TPB regional travel demand model. This effort entailed 1) Reviewing the recommendations made by the previous consultant who held the contract from FY 2012-2014; 2) A review of best modeling practice, based on CS's national experience with various MPOs; 3) Soliciting stakeholder input through a web-based survey and a meeting; and 4) Other recent stakeholder input, specifically a letter from the regional transit authority, the Washington Metropolitan Area Transit Authority (WMATA).[1] The findings from all four of these activities are discussed in the following sections.

2.0 Review of Recommendations from the Previous Consultant

Under COG Contract Number 14-056, COG requested that Cambridge Systematics (CS) review the models development recommendations made by the previous consultant, AECOM, who held the contract from FY 2012 through 2014. CS' review of the recommendations are compiled in a separate report.[2]

Table 2.1 summarizes CS conclusions and next steps based on the review. The term "refine" is used to indicate recommendations that should be refined further before undertaking them. "N/A" means "not applicable," either because the recommendation has already been addressed or it is no longer applicable. Items appear in the table below in the same order that they appeared in the report.

[1] Shyam Kannan to Patrick Wojahn, Letter, (October 30, 2014), "Item 5 - Letters Sent and Received," pp. 29-30, from the Nov. 19, 2014 meeting of the NCRTPB, http://www.mwcog.org/uploads/committee-documents/a11XXl9X20141113131836.pdf.

[2] Review of Consultant Recommendations from FY 2012-2014 of the COG/TPB Travel Demand Modeling Consultant-Assistance Project (June 30, 2015).

Table 2.1 Summary of Review

Recommendation	Year	Level of Effort	Importance	Next Step
Software Issues				
12.1: Review Modeling Software	2012	Low	High	Yes
12.2: Review of TPB Scripts: Improve model input efficiency	2012	Low	Medium	Refine
12.4: Reducing Run Times: Batch process improvements	2012	Medium	High	Yes
12.5: Review of TPB Scripts: Changes to mode choice model	2012	Low	Medium	Yes
12.9: Reducing Run Times: Enhance usage of parallelization	2012	Medium	Medium	Yes
13.4: Speed Feedback: Enhance focus on speed validation	2013	High	Low	Refine
13.5: Speed Feedback: Adjust volume delay functions for freeways	2013	Medium	Medium	Yes
Model Inputs				
12.3: Error Checking Automation	2012	Low	Medium	Yes
Model Components/Structure				
14.11: Mode Choice: Revise model specification and calibration approach	2014	High	High	Refine
12.13: Mode Choice: Air passenger model for all modes	2012	High	Low	Yes
13.8: Mode Choice: Migrate to ModeChoice	2013	N/A	N/A	N/A
14.10: Mode Choice: Migrate to ModeChoice	2014	Medium	High	Yes
12.14: Airport Choice Model	2012	High	Low	Yes
12.15: External Model	2012	High	Low	Yes
12.16: Visitor Model	2012	High	Low	Yes
HOT/Managed Lanes				
12.10: Improve single step assignment results	2012	N/A	N/A	N/A
13.1: Demonstrate benefits of HOV choice model	2013	Medium	High	Refine
13.2: Test integration of HOV choice model and multi-class assignment procedure	2013	Medium	High	Refine
14.3: Pursue improvements in HOV/managed lanes modeling	2014	Medium	High	Refine
14.4: Recalibration of HOV choice model with count data from HOT lanes	2014	Medium	High	Yes
14.5: Shift application platforms for better integration and enhancement potential	2014	Medium	High	Refine

Recommendation	Year	Level of Effort	Importance	Next Step
14.6: Refinement and testing of toll-setting procedure	2014	Medium	High	Refine
Transit Modeling				
12.11 and 12.12: Start conversion process from TRNBUILD to PT	2012	High	High	Yes
12.6: Mode choice segments	2012	High	High	Refine
12.7: Move to latest LineSum software	2012	Completed	Completed	N/A
12.8: Enhance walk access scripts	2012	Completed	Completed	N/A
13.6: Reconfiguration of transit access links to support PT	2013	Completed	Completed	N/A
13.7: Design and implement PT fare calculation methods	2013	Medium	High	Yes
14.2: Further enhancement of ArcPy scripts	2014	Medium	High	Yes
14.7: Document TRNBUILD to PT conversion procedures	2014	Low	High	Yes
14.8: Calibrate PT parameters	2014	High	High	Yes
14.9: Path conditioning	2014	Low	Medium	Refine

3.0 Best Practice Considerations

Cambridge Systematics has worked with many travel models, particularly in large urban areas, and maintains participation in the Transportation Research Board. Based on this experience, CS is in a position to offer a practical perspective on what is considered “best” practice in travel demand modeling. This section presents a brief summary of modeling practices at agencies representing large metropolitan areas in the U.S. This summary focuses on model elements and features that are largely unrelated to the distinction between trip-based and activity-based modeling. The topics discussed in this section include the following:

- Land use inputs;
- Multimodal modeling;
- Highway assignment;
- Road pricing/managed lanes;
- Transit modeling;
- Freight/truck modeling; and
- Visitor travel.

3.1.1 Land Use Inputs

Regardless of the type of model used, land use and socioeconomic data inputs are critical to travel demand models. These inputs include population and households, employment, school and university enrollment, and land use characteristics. All models require these data at the transportation analysis zone (TAZ) level, though some advanced models also use smaller geographic units, such as parcels. While there are common sources of data for current (and, often, past conditions), forecasts of these data, which are necessary for model application for forecast year scenarios, are obtained in ways that vary widely from one region to another.

Population/Households

The typical required model inputs are total households at the TAZ level, usually cross-classified by characteristics such as number of persons, number of workers, income level, number of vehicles, and number of children. Models often employ two-dimensional cross-classifications of subsets of these variables, frequently using different cross-classifications for different travel purposes (for example, workers by income level for work travel, persons by income level for shopping, etc.). Occasionally, three dimensional cross-classifications are used in a limited way (for example, workers by income level by vehicles for work travel).

The use of synthetic populations has come into practice in many regions since disaggregate person/household inputs is a requirement of modern activity-based models. These synthetic populations represent the entire population of the modeled region. For each synthetic household and person, there is a rich variety of characteristics, including person age, gender, and worker/student status, and household income level. Activity-based models can take advantage of a large number of input variables and are not limited to two or three cross-classification dimensions.

The decennial U.S. Census, with its 100 percent sample, is the best source for data on households and persons. Information on certain household characteristics, such as income level, is not available from the decennial census; nor are cross-classifications of household characteristics. A primary source for this type of data is the Census Bureau's Public Use Microdata Sample (PUMS), which uses data from the American Community Survey (ACS). The ACS has a much smaller sample than the decennial census. PUMS data also are used to develop synthetic populations by providing marginal control totals for several input variables and cross-classifications of variables.

The means of forecasting household and population data vary widely among different regions, and developing forecasts is more complicated in regions that cover many jurisdictions (such as metropolitan Washington, D.C.). Forecasts must include not only total population and households, but also household (income levels, number of children, etc.) and person (age, worker status, etc.) characteristics.

In many places, forecasting population and households is not the responsibility of the agency (or part of the agency) responsible for model development, and forecasts done by others are sometimes imposed on the model at some geographic level, often a coarser level of detail than

TAZs. In many cases, modelers are required to use population forecasts developed by public agencies for other purposes. It is therefore difficult to document best practices in population forecasting from a modeling standpoint. The issue is often further complicated by political considerations that could impose constraints on the results of analytical forecasting procedures, including land use models (see below).

Vehicle availability (ownership) information is available directly from PUMS. Research indicates, however, that changes in demographics and in the transportation system can significantly affect vehicle ownership[3]. For example, households located with good access to transit service tend to own fewer vehicles. It therefore makes sense to incorporate into the travel model a component capable of estimating the effects of multimodal transportation level of service and demographics on vehicle availability. State-of-the-practice vehicle availability models, which normally use a multinomial or ordered response logit formulation, are generally simpler and have lower estimation and validation data requirements than some other more commonly used model components; for example, mode choice models.

School/University Enrollment

Because travel by elementary and secondary school students is quite different than travel for other purposes, it is good practice to model school as a separate trip or activity purpose. In regions with significant university/college populations, the same holds for university/college travel. The best measure of school/university travel at the site of the educational institution is enrollment. Public school enrollment data sources are generally available from local/county governments or school districts, but private school information may be more difficult to obtain. University/college enrollment is not difficult to find for larger institutions, but information for smaller or specialty institutions of higher learning is not always readily available. Since the number of such institutions is usually not large, it may be most efficient to contact them individually to obtain accurate information.

Forecasts of school and university enrollment may be difficult to obtain. While overall growth in school enrollment may be assumed to be proportional to the growth in the number of children (from the population forecasts), the locations of new schools often are unknown, especially for longer-term forecast scenarios; these locations are often simply asserted. There is a body of research into the accuracy of university enrollment forecasts, often by institutions themselves, but this research has not really been applied in developing data for travel models.

Employment

Employment data inputs are divided into a set of 10 or fewer categories. Data sources for employment include public sources such as state agencies, U.S. Census Journey to Work (JTW) data (from the ACS), and Longitudinal Employer-Household Dynamics (LEHD), also from the Census Bureau. Commercial data sources also are available. Each source has its limitations.

[3] Bhat, C., , Sen, S., and Eluru, N. "The Impact of Demographics, Built Environment Attributes, Vehicle Characteristics, and Gasoline Prices on Household Vehicle Holdings and Use." *Transportation Research Part B*, 43(1), 1-18. 2009.

The JTW data is based on a small sample and is unreliable for small levels of geography such as TAZs. LEHD is based on a much larger sample, but excludes employees not covered by unemployment insurance. Any public or commercial data source needs to be checked by analysts with local knowledge because there are invariably issues with any data source, ranging from being out of date to the "headquarters problem," where all employees of a particular employer with multiple locations are assigned to a single site.

Employment categories are typically defined no finer than the level of two-digit North American Industry Classification System (NAICS). It is impractical to use a much larger number of more detailed employment types because of the insufficiency of data for so many categories in model estimation, application, and validation; and the difficulty of forecasting at that level. At the same time, there can be substantial differences in travel attractiveness among different employment types. Therefore, it is desirable to use at least a few employment categories.

Employment forecasts are beset with the same difficulties as population forecasts as described above, and existing employment forecasts are often available only at gross geographic levels such as counties.

Density Variables

Density variables can be valuable in explaining differences in travel behavior. Such variables may include simple densities of the socioeconomic variables used elsewhere in the model (e.g., population and employment densities); and can therefore be developed easily using measures of land area. Other density measures can be useful; for example, the density of intersections is a useful measure of development intensity and type. Density variables need not be limited to individual TAZs; measures that use unit area buffers may be more accurate indicators of the nature of development in an area.

Land use models attempt to forecast the amount of development for future scenarios based on variables that may include measures of transportation accessibility among other factors. While there is experience at various MPOs with using land use models, no single approach has become universally accepted; land use modeling approaches continue to evolve. There is little question that development patterns are affected by transportation system changes, and land use models provide an objective way to estimate those effects. But such models can be complex and data hungry, and they may require significant resources to build and maintain. There are many factors that affect future land use, however, and existing land use models handle these effects in different ways. There are, no doubt, benefits to using land use models to help develop travel model inputs; the question, however, is whether the benefits outweigh the costs.

The use of land use models in large urban areas is not universal. Many areas use established models, including PECAS and UrbanSim, while others use procedures developed in-house. Some areas develop forecasts using expert knowledge, including Delphi type approaches. Some areas use a combination of models and expert knowledge. The survey of peer MPOs explores the use of land use models (i.e., see Report 2 of 3).

3.1.2 Multimodal Modeling

Mode choice models, whether in the context of trip-based or tour-/activity-based models, continue to use nested logit formulations. While auto modes are usually subdivided by auto occupancy level, and access mode continues to be a differentiator among transit submodes, practice has been moving away from "deep" mode choice models with many nests and alternatives based on transit technology. For example, a peer review performed for the Baltimore Metropolitan Council in 2013 recommended that the mode choice process "emphasize unique service variables in network coding (e.g., station type), elaborate path building choice logic, and keep the mode choice model shallow" and that the model "allow multiclass transit assignment by user class (income group and age)."[4]

Research summarized in the Transit Cooperative Research Program (TCRP) Report 166 indicated that mode choice models can be improved by defining alternatives that reflect "characteristics of premium services and paths… rather than rely on mode or technology labels (e.g., 'light rail' or 'express bus')." However, the research was specific to the environments in which it was conducted and did not produce a specific method for defining paths that could be used in other contexts. Hence, the implementation of this type of modal alternative definition has not yet made its way into widespread practice.

Nonmotorized travel has been included in some travel models for more than 25 years, and its inclusion has become fairly common in large urban areas. Very few of the largest metropolitan areas in the U.S. do not consider nonmotorized travel at all, although some agencies (including NCRTPB) do not currently carry nonmotorized travel all the way through the mode choice stage.

Some areas combine all nonmotorized travel into a single alternative for mode choice while others have begun to consider walk and bicycle trips separately in their models; this is especially true in areas where activity-based models are being implemented. While there are no known regional models that assign walk trips (since this is of limited utility), a few areas, such as Los Angeles[5] and San Francisco[6], have begun implementing explicit modeling of bicycle travel, including path choice. These efforts are still in early stages; and so while there are no proven methods that can be immediately implemented in in other areas, the efforts are worth tracking for use in the near future. A recent development that will aid in the development and

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[4] *Baltimore Metropolitan Council (BMC) Activity-Based Travel Model Peer Review Report*, Travel Model Improvement Program (TMIP) (Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, April 2014), 18, http://www.fhwa.dot.gov/planning/tmip/resources/peer_review_program/bmc/report_3/index.cfm.

[5] Los Angeles County Metropolitan Transportation Authority (2014). "Los Angeles County Metropolitan Transportation Authority Bicycle Travel Demand Model: Phase II Model Description." http://www.scag.ca.gov/committees/CommitteeDocLibrary/mtf032614_BicycleModelPaper.pdf.

[6] Hood, J., E. Sall, and B. Charlton. "A GPS-based Bicycle Route Choice Model for San Francisco, California." *Transportation Letters: The International Journal of Transportation Research (2011) 3: (63-75)*.

validation of nonmotorized model components is the introduction of automated passive bicycle and walk data collection methods[7]. While these methods are not yet in widespread use, their popularity is growing.

3.1.3 Transit Modeling

In many ways, transit is one of the more difficult issues to deal with in models, even more so than nonmotorized travel. While it is not hard to create a model that estimates fairly well the number of transit users or boardings at a regional level, it is more difficult to get accurate estimates at more disaggregate levels – individual lines, transit paths, geographic subareas, and demographic segments (e.g., lower-income riders, persons without available autos).

There are usually fairly rich data sets available to portray transit use in a region. Extensive, frequently conducted transit rider surveys have become standard practice in regions with significant transit use or who are considering transit service expansions. Ridership counts at the line level, often by time of day, are often available; and station-level boarding counts for fixed guideway service may be available as well. Many regions have information on park-and-ride lot usage. Modeling the observed patterns of transit use, as illustrated by these data sets, often proves problematic without extensive use of factors and constants that may not directly relate to behavioral factors. This is partly due to the much lower numbers of transit users (compared to auto users), making error rates relatively high.

Multipath transit assignment procedures have become typical in areas with large transit systems. The specific procedures used are dependent on the modeling software – in Cube, PT is the current standard, though some models, such as the COG/TPB model, use older processes. None of the available aggregate procedures accurately replicates the route choice decisions typically observed from transit rider surveys.

An important consideration in this regard is that transit route choice decisions are not made in the same way as auto route choice decisions. The latter are assumed to be made by minimizing impedance, which is dominated by travel times that are (relatively) easy to estimate. Minimizing impedance for transit path choice is more complex, as out of vehicle time and out of pocket costs (fares, and sometimes parking) are more important relative to in-vehicle time, and transfers between lines also have a (perceived) disbenefit beyond simply the transfer time itself. The ways in which riders value the various components of travel impedance vary widely, making the average tradeoffs between them that a model assumes inaccurate for many travelers[8].

Furthermore, in typical static transit assignment procedures, individual bus runs are not treated separately; rather, each route is represented by average conditions during time periods that typically are several hours long. In addition, interactions between routes, both

[7] AMEC E&I, Inc., Sprinkle Consulting, Inc. (2011). *Pedestrian and Bicycle Data Collection Task 2 – Assessment*. Federal Highway Administration, HPPI-30.

[8] The basis for this statement is that transit paths reported on rider surveys vary from paths built through path builders that assume average tradeoffs as documented in the skim settings.

transfer candidates and competing routes, are not considered. For example, if an origin-destination pair is served by two overlapping routes traveling the same path, and the routes have the same headway, the transit path builder may allocate travelers between these locations differently, depending on the algorithm used. Some algorithms might assign all of the travelers to one route while others might split the travelers evenly between the routes. The reality might be different; if the headways are 20 minutes, and one route always arrives 5 minutes before the other, that route might be expected to carry 75 percent of the riders between the two locations.

Regardless of (and perhaps because of) these issues, it is critical to validate path choice processes and the associated parameters using transit rider surveys. This should be done before model estimation since network skims are key inputs into the estimation process. No path building process will be able to recreate all observed transit path choices because the path builder settings, which govern the tradeoffs between the various components of path impedance, will not match how every survey respondent values these components. However, there are still aggregate level checks that can be done, such as comparing the number of transfers between survey results and the chosen paths from the model.

There are several advantages of using “shallow” sets of modal alternatives in mode choice. These include having to create fewer skims for mode choice model estimation and application and obviating the need for rules to assign multimodal transit trips to a particular modal alternative. A disadvantage is that differences in the perceived experience on “premium” versus “nonpremium” modes are not directly considered in mode choice utility functions, which can make validation of transit assignment by mode more difficult. One way to address this is by effectively discounting in-vehicle time for “premium” modes.

One of the most important findings of examinations of issues with transit model components is that many “validated” models have inaccuracies in transit networks and the representations of transit paths. Model practitioners, researchers, and the Federal Transit Administration (FTA) have found that without careful attention to network accuracy, other transit modeling improvements will have limited effectiveness.

3.1.4 Highway Assignment

The state of the practice for highway assignment in large urban area models is static equilibrium assignment. Some regions have begun to develop regional dynamic traffic assignment (DTA), but there are no peer agencies known to be using DTA exclusively for their planning analyses[9]. Some agencies have subregional or corridor DTA implementations.

The Second Strategic Highway Research Program (SHRP) project C10 implemented regional DTA in connection with activity-based travel demand models in Jacksonville, Florida, and Sacramento, California. However, the MPOs in these regions have not adopted the C10 models for their planning analyses. Some larger areas, including Chicago and San Diego, have regional DTA in various stages of implementation while others are actively developing such

[9] MWCOG survey of peer MPOs to assess the state of modeling practice, conducted March 6-25, 2015.

capabilities. The Baltimore region, among others, received a SHRP C10 implementation grant from the Federal Highway Administration (FHWA) to implement regional DTA, but these projects are at least a couple of years away from completion.

It should be noted that while disaggregate demand models such as activity-based models offer substantial analytical advantages related to minimizing aggregation error, all of the operational activity-based models in the U.S. use static, aggregate assignment procedures for regional highway assignment. This means that agencies with such models cannot yet take full advantage of a completely disaggregate modeling approach. This recognition has probably accelerated the research into integrated activity-based/DTA models.

3.1.5 Road Pricing/Managed Lanes

The choice of whether to use priced roadways when traveling is essentially a route choice decision where cost has a much greater effect relative to time than in route choice among free routes. The route choice decision also affects mode choice since the time and cost of traveling by auto are affected by whether priced roadways are part of the auto route.

The conventional four-step modeling process allows for some level of analysis of priced roadways. The highway networks include toll values, and the equilibrium assignment procedures minimize path impedance considering both time and cost by using values of time that reflect the tradeoff between these variables. The cost and time values along highway paths can be used in the trip distribution and mode choice components.

The main limitations of the way that priced roadways are modeled are:

- Conventional household travel surveys do not provide much information from which to estimate values of time. In most areas, the amount of travel that uses priced roadways, or has the option to do so, is relatively small. Furthermore, these surveys typically do not collect route choice information (though the amount of toll paid may be collected). The main way in which values of time enter into the models is in mode choice, where the utility functions have cost and time coefficients. However, by necessity, mode choice model parameters reflect not only auto users, but also nonauto users, who generally have lower values of time. Furthermore, estimated mode choice model parameters generally result in lower implied values of time than do studies of route choice in the context of toll roads. It is common to use values of time based on such studies rather than the local survey data, and so these values do not reflect variations among local travelers or differences between the local area and the estimation contexts of the original studies. It also should be noted that the values of time implied in path building are not always consistent with those implied in mode choice models, especially since mode choice models are segmented by tour or trip purpose while path building usually is segmented only by time of day and mode.

- Use of a single value of time for a travel market segment means that the entire market will choose to use or not use a particular choice that includes a priced roadway. In reality, some fraction of the travelers in a market would use the priced roadway (those with values of time above the threshold where the time saved on the route with priced roadways offsets the additional toll cost). But only a single value of time can be used for each travel segment that is assigned; meaning that the choice is made for the entire segment under the assumption that they all have the average value of time. In reality, each individual has his or her own value of time, and even individual values of time might vary depending on the situation. Modelers have addressed this issue through additional segmentation of the highway trip tables used in assignment and assigning different values of time to more market segments. But the number of segments that can be accommodated is limited, and usually segments are based on gross definitions such as vehicle type (auto versus truck) and income levels. This type of segmentation ignores differences within segments, as well as differences in values of time that are unrelated to the segmentation variables.

Due to their disaggregate nature, activity-based models provide some advantages in the analysis of priced roadways. Because every individual's activities and travel are simulated, a value of time for each individual (often varying by activity/tour purpose) can be simulated and used throughout the set of travel choices being modeled. The issue of being able to estimate the value of time distributions using household survey data can be challenging, however, due to limited observations of toll paying. This was first overcome in San Francisco, where data from a specially designed stated-preference survey were used to estimate the value of time distributions.[10] While such stated-preference survey data sets are unavailable in many areas (though similar surveys could be conducted relatively inexpensively), some areas, including Baltimore, have used information from the San Francisco survey results to estimate partially-constrained value of time distributions for use in activity-based models.

Some travel models, including both trip-based and activity-based models, include auto travel using priced roadways as separate alternatives in mode choice. The advantage of doing this is that different values for time and cost related to the priced and free alternatives can be used as inputs to mode choice. However, as is the case with many modeling practices that have evolved over time, this approach has been introduced without basic research indicating whether it is better than, as good as, or worse than previous practice. Introducing tolled versus free alternatives in mode choice introduces several problems (beyond running counter to the trend of "shallower" mode choice models).

The main challenges associated with the use of segmented models are:

- The toll versus free segmentation does not truly separate travelers who use priced roadways from those who do not. While the "free" segment does not use toll roads in assignment, the "toll" segment may or may not use them.

- The sample sizes in household surveys for toll road users may be very small in some regions. For example, in the Baltimore region (which shares a household survey data set with the NCRTPB region), only 11 shared ride work tours with a toll paid were reported in

[10] Sall, E., E. Bent, B. Charlton, J. Koehler, and G. Erhardt (2010). Evaluating Regional Pricing Strategies in San Francisco – Application of the SFCTA Activity-Based Regional Pricing Model. Proceedings of the 89th Annual Meeting of the Transportation Research Board (TRB), Washington, D.C.

the household survey[11]. This is an issue not only for model estimation, where it can be impossible to get statistically significant parameters for toll utilities, but also for model validation since the number of travelers in each segment cannot be estimated with statistical significance by expanding the survey data.

- A related issue is that the segmented mode choice model is made more complex by doubling the number of auto alternatives. This adds computation time to the model.
- The binary nature of the toll versus free choice is an oversimplification. There may be multiple viable paths that use priced roads, and the best path may depend on the assumed value of time. Some "toll" paths may use only a small length of priced road while incurring a small toll cost. So the skims used to identify the best "toll" path may not accurately portray the times and costs associated with the paths used by everyone in the "toll" segment.

As an alternative, the Baltimore region is implementing a new approach as part of their activity-based model.[12] This approach combines the use of simulated values of time from a distribution with segmentation of trip tables used in aggregate highway assignment by value of time level. The segments to be used for both highway assignment and mode choice are defined based on the value of time distributions used in the activity-based model. A set of highway skims is developed using the implied average value of time for each level. In the mode choice application, the skims used for a particular traveler are those for the value of time range in which the traveler's simulated value of time falls. Highway assignment is performed using separate trip tables for each value of time range segment, and skims for the next iteration of the model will be developed for each segment. This approach does not eliminate all aggregation, as the value of time ranges are aggregate, with associated average values, and the highway assignment process is aggregate. In the future, it is hoped that a disaggregate assignment process from the C10 implementation project will replace the static equilibrium procedure.

3.1.6 Freight/Truck Modeling

It has been common for urban travel demand models to have truck model components that do not distinguish trucks carrying freight from those being used for other purposes. In such models, trucks may be segmented by two or three size categories. Typically, the models include truck trip generation and distribution models, and the resulting truck trip tables are assigned along with auto vehicle trips in the multiclass highway assignment.

Local data with which to estimate truck trip generation models often is unavailable. A common source for model parameters is the original 1996 Quick Response Freight Manual (QRFM).[13]

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[11] CS' evaluation of the household survey completed for the Baltimore ABM.

[12] Rossi, T., B. Pandey, J. Lemp, and M. Milkovits (2015). Improving the Treatment of Priced Roadways in Mode Choice. Presented at the 15th TRB National Transportation Planning Applications Conference, Atlantic City, New Jersey.

[13]Note: The 2007 update of this manual does not include new trip rate parameters.

The National Cooperative Highway Research Program (NCHRP) Synthesis 298 (2001) includes a variety of truck trip rates compiled from around the country. These sources are somewhat dated, however, and the QRFM rates are based only on a single urban area (Phoenix) and are 20 years old.

It is becoming more common to have separate freight and nonfreight truck model components. However, freight must be considered beyond the urban area as much of it is associated with long-distance travel. Recent models often use commercial sources such as TRANSEARCH and ATRI for truck/freight data, as well as publicly available data such as Freight Analysis Framework (FAF). One method is to obtain freight movement origin-destination tables from one of these sources and to disaggregate the information to TAZs and external stations. The level of disaggregation required depends on the data source and the specifics of the purchase; the vendors will provide data for larger areas and finer levels of detail at greater cost.

3.1.7 Visitor Travel

Visitor travel (made by nonresidents of the model region) is usually considered as a separate model component in urban models. Most large urban areas do not include such a component in their models, though more areas are starting to consider them, especially areas with significant amounts of such travel. For example, New York is considering adding such a component.

Because household travel surveys do not include nonresidents of a region (unless they are staying with a household in the region that is participating in the survey), models based on such survey data sets do not explicitly include visitor travel. The trips made into and out of the region might be included in components such as external travel or airport models, but travel made by visitors while in the region is not. Since some model validation sources such as traffic and transit ridership counts include all travel made by both residents and nonresidents, there is a bit of a disconnect; and model calibration implicitly includes adjustments to resident travel models to “expand” it to include visitor travel. However, this practice provides no way of accounting for the different travel characteristics and patterns of visitors to the region without collecting information on them and explicitly modeling them.

A primary data source for visitor models estimated using local data is a hotel visitor survey. While not all visitors to a region stay in hotels, this presents the best opportunity to obtain data from a large sample of visitors. Usually, these are diary-type recall surveys of all travel made during the previous 24 hours, as well as travel to and from the region. These surveys can be difficult and expensive to conduct, and response rates can be fairly low. Depending on the characteristics of visitor travel and of hotels in a region, the sample may need to be quite diverse and therefore large. Recently, there has been exploration of using cell phone data to inform visitor travel models, but this remains an emerging area.

Existing urban area visitor models are trip based with components, including trip generation, trip distribution, mode choice, and perhaps time of day. The hotel surveys provide the type of information that would be suitable for tour-based models, but so far there are no known examples of such.

4.0 Stakeholder Input from the Survey and Stakeholder Meeting

To gather background information that could be used to develop the strategic plan for development of the COG/TPB regional travel demand model, CS and COG/TPB staff conducted two surveys:

- A survey of users of the COG/TPB travel demand model (referred to as "modeling stakeholders").[14]
- A survey of MPOs considered peers of TPB.[15]

The next section of the report discusses the stakeholder survey, and its subsequent stakeholder meeting. The survey of peer MPOs is discussed in the next report (Report 2 of 3).

4.1 Background

The stakeholder survey was conducted between February 13 and March 3, 2015. The survey instrument is included in Appendix A. Additional input was sought at a stakeholder meeting held at COG on February 27, 2015.

The survey was distributed to the broad categories of stakeholder listed below, which comprised approximately 160 individuals:

- COG/TPB Travel Forecasting Subcommittee;
- People who have requested the COG/TPB model or its inputs/outputs in the last year;
- Selected COG/TPB staff who are familiar with the COG/TPB model or its data; and
- Additional individuals who request it.

[14] MWCOG survey to solicit stakeholder input from users of the COG/TPB regional travel demand model, conducted February 13 to March 3, 2015, interview by Metropolitan Washington Council of Governments/National Capital Region Transportation Planning Board and Cambridge Systematics, Inc., Web-based survey, February 2015.

[15] MWCOG survey of peer MPOs to assess the state of modeling practice, conducted March 6-25, 2015, interview by Metropolitan Washington Council of Governments/National Capital Region Transportation Planning Board and Cambridge Systematics, Inc., Web-based survey, March 2015.

The survey broadly covered the following topics:

- Respondent Information (name, title, agency, etc.);[16]
- Experience running the model/using input and output;
- Model application – project types, geography, mode;
- Level of interest regarding types of policies;
- Level of satisfaction with current model and how well it addresses specific issues; and
- Importance of specific emerging transportation trends.

The following section discusses the results of the survey.

4.2 Results

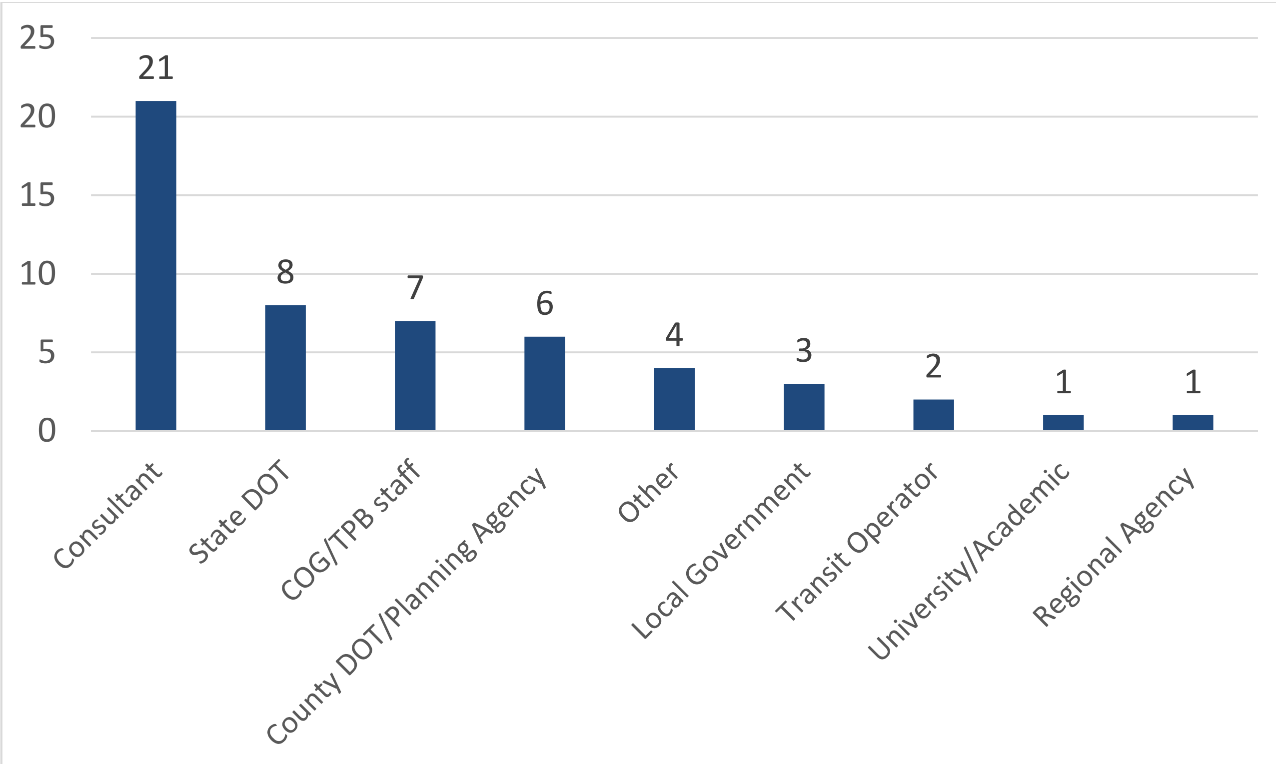
This section discusses the responses to both the categorical and non-categorical (open-ended) questions, including comment fields. Survey respondents were informed that their responses would be kept confidential. Thus, for categorical questions, this means releasing information only in an aggregate/summarized format. For the non-categorical questions, the only way to present information would be to present it in a way where one cannot discern the respondent's identity.

4.2.1 Categorical questions

Of a total of 53 respondents, approximately 40 percent were consultants and the remaining 60 percent comprised state, local, and transit agencies. Seven of the 53 respondents were COG staff who were included in the survey for their unique perspective as developers of the model, and the only entity that performs air quality analyses for the region. A small number of respondents (2) also were from academia. Figure 4.1 illustrates the distribution of respondent organizations.

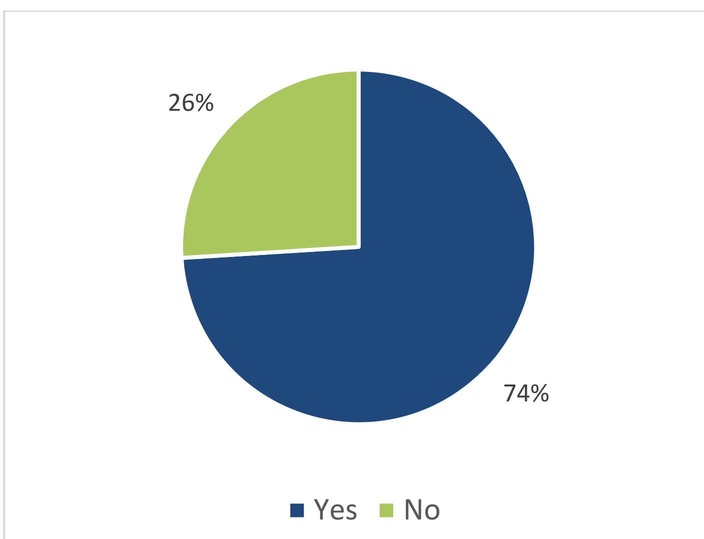
[16] Name was optional, but title and agency were mandatory fields.

Figure 4.1 Distribution of Respondent Organizations



As illustrated in Figure 4.2, approximately 74 percent of the respondents responded affirmatively to using the COG/TPB model, about 20 percent had only used the model input or output information, and the remaining 7 percent had no experience executing the model or working with the inputs or outputs.

Figure 4.2 Respondent Usage of Model During Past Three Years



Opportunities for Improving the Model

An essential part of understanding the model's strengths and opportunities for improvement was to get a sense of the level of interest that the respondents had in key transportation policies in the region. The responses to Question 9 (Please indicate the level of interest in your agency, or for your clients, regarding the following transportation policy issues) are shown in Figure 4.3. The graphic shows issues of interest to the stakeholder community on the right of the y-axis, and issues of less or no interest to the left of the y-axis. Issues such as increasing regional accessibility, reducing traffic congestion, land-use transportation coordination, and provision of multimodal options are some of the issues that attract high levels of interest from the community.

Question 10 of the survey asked about the level of satisfaction with the current model in several areas (Please indicate your level of satisfaction with the current regional travel demand forecasting process in the following areas). Figure 4.4 shows that the community is very satisfied in terms of the overall comfort with the model, model documentation, and technical support. There is also a high level of satisfaction with the model inputs and outputs. Areas that the users are not happy with are model run times, adaptability, and ease of use.

The objective of Question 11 (In your opinion, how well does the TPB's current regional travel demand forecasting process address the following traditional transportation issues?) was to gauge how well the model addressed traditional transportation issues; however, the focus of Question 12 (In your opinion, how important is it for an updated TPB regional travel demand forecasting process to address the following emerging transportation issues?) was more to do with how important it was for the model to address emerging transportation issues. Figures 4.5 and 4.6 illustrate the stakeholder opinions on Questions 11 and 12, respectively.

Traditional transportation issues that the bulk of the stakeholders thought the model addressed well included, roadway projects and network enhancements, land use scenarios, and transit projects and service improvements. The respondents of the survey felt that the model did not address several traditional modeling issues well including, travel demand management, transit submode analysis, and transit oriented development. Although several respondents (35) thought the model addressed the issue of competition among/choice of travel modes, somewhat well to well, there were approximately 20 percent who felt that it did not.

Two emerging trends important to close to 90 percent of the respondents were peak spreading and travel time reliability. Travel behavior for specific population segments, greenhouse gas analysis, telecommuting, uncertainty in model outputs, and transit crowding were some other emerging trends that a large number of respondents said were important to them.

Issues related to increasing regional accessibility and reducing traffic congestion were also identified as issues of high interest to the region. Modeling many of these issues would require more sophisticated modeling techniques, likely leading to higher model run times, which is the number one concern of the stakeholder community.

Figure 4.3 Stakeholder Interest in Policy Issues

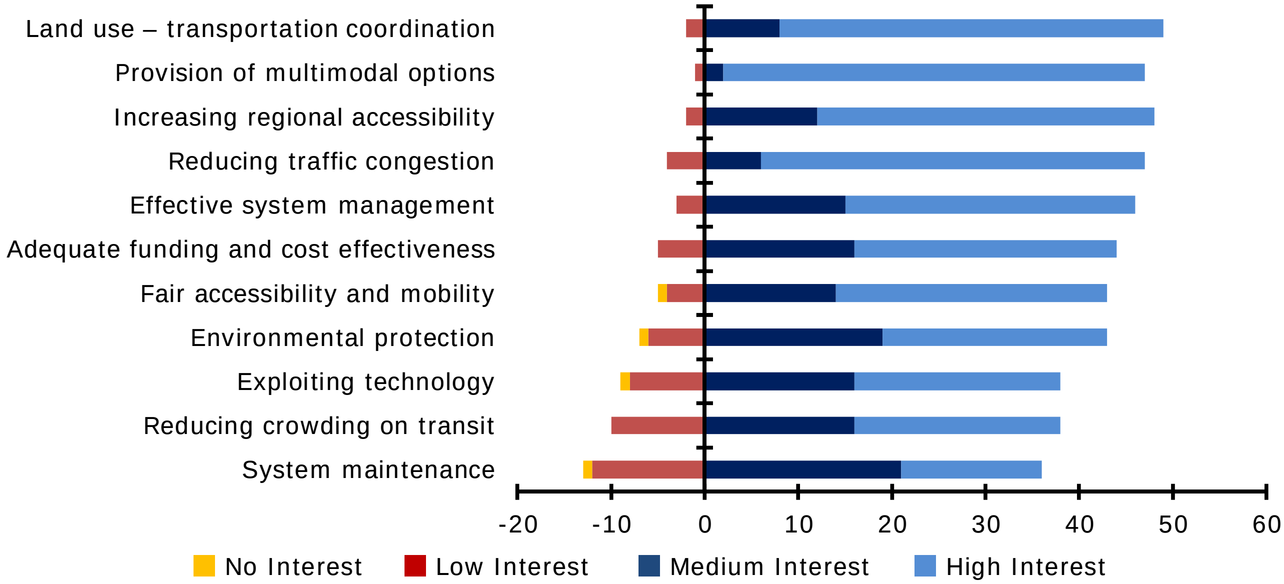


Figure 4.4 Stakeholder Satisfaction with Current Model

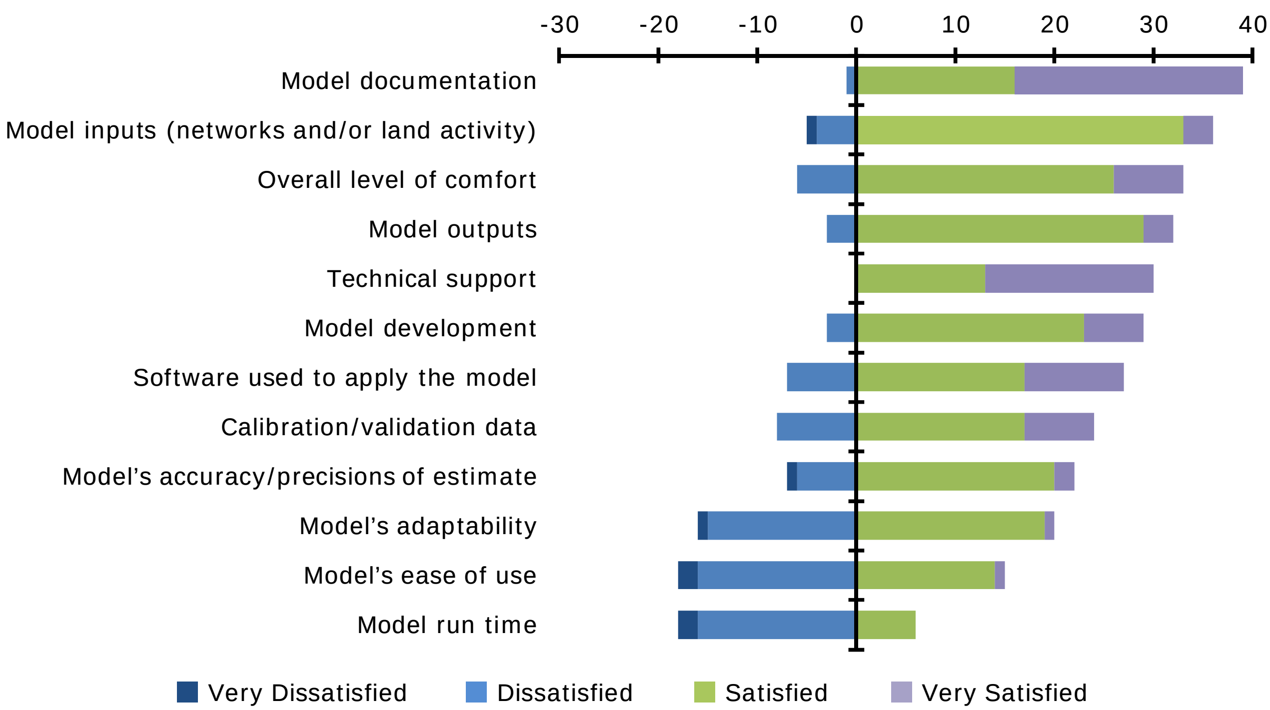


Figure 4.5 Stakeholder Assessment of Ability to Address Issues

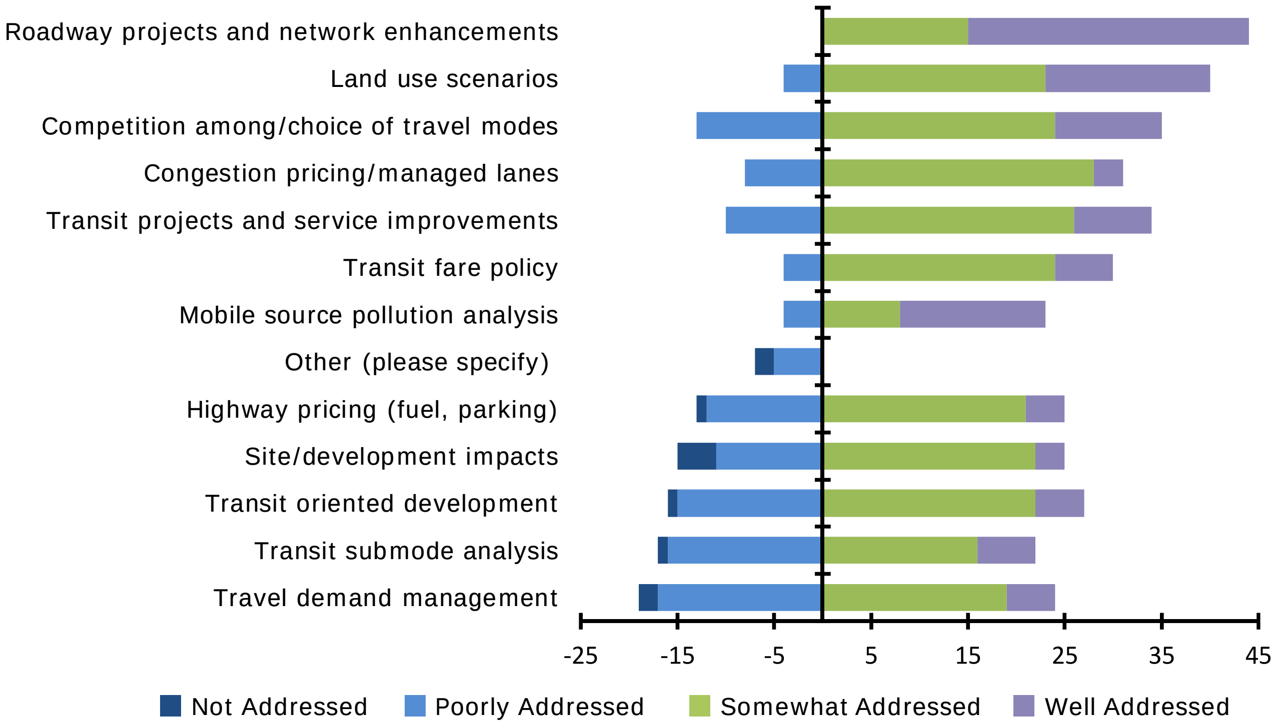
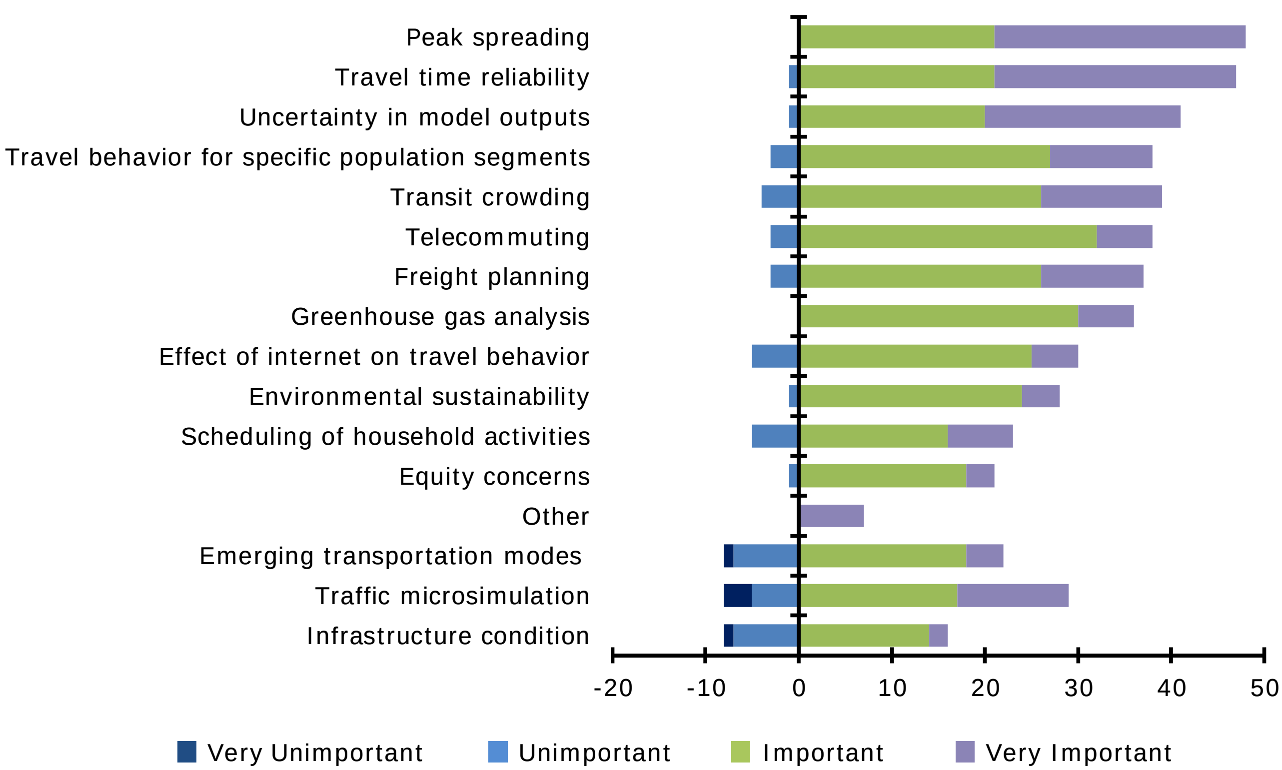


Figure 4.6 Stakeholder Assessment of Importance of Issues



Model Uses

The TPB model is used for a wide variety of applications. Figure 4.7 illustrates the different applications that respondents use the model for.

Thirty or more of the 53 respondents indicated that they have used the model for regional planning, corridor studies, and scenario planning. Approximately 50 percent have applied the model to non-New Starts and land development studies.

The model also has been applied to a number of public transit projects (Figure 4.8), including bus, heavy rail, bus rapid transit (BRT), light-rail transit (LRT), and streetcar modes. Also, 19 of the 53 respondents have used the model for nonmotorized transit applications.

Figure 4.7 Types of Applications as Reported by Stakeholders

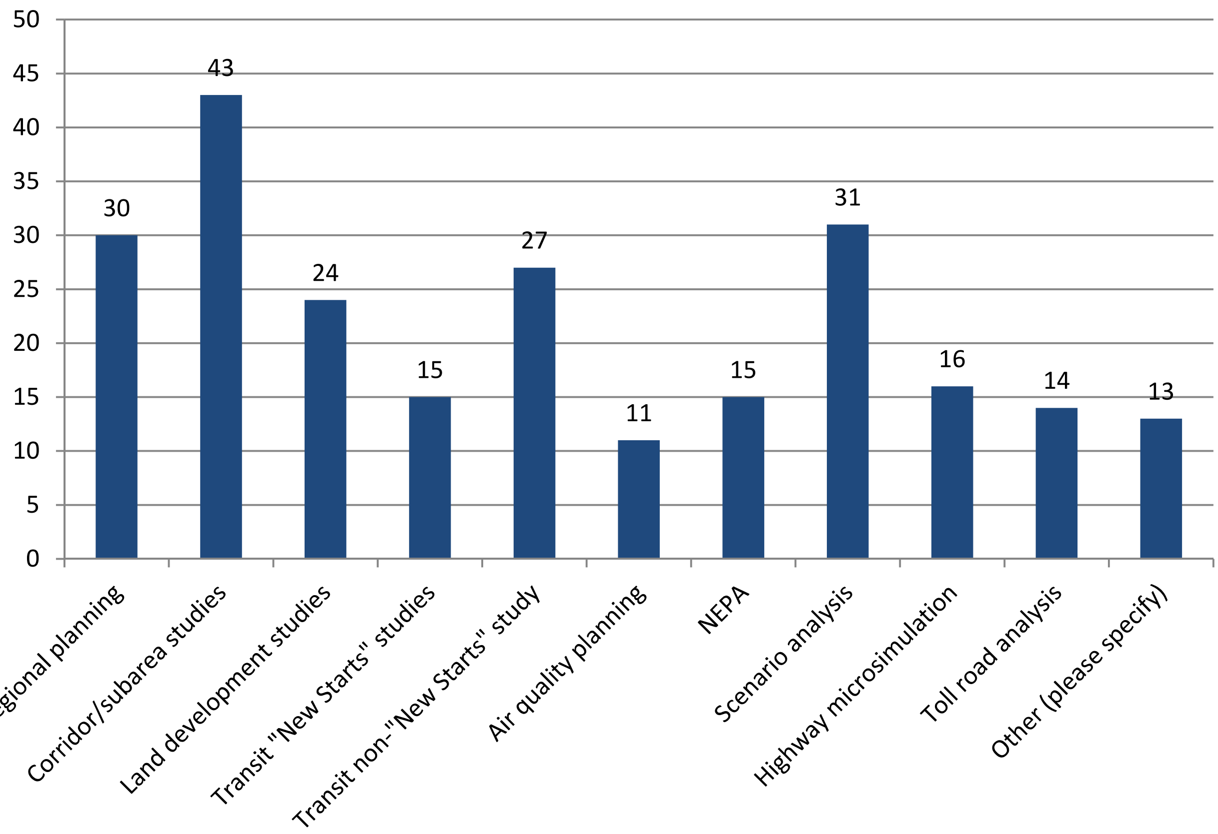
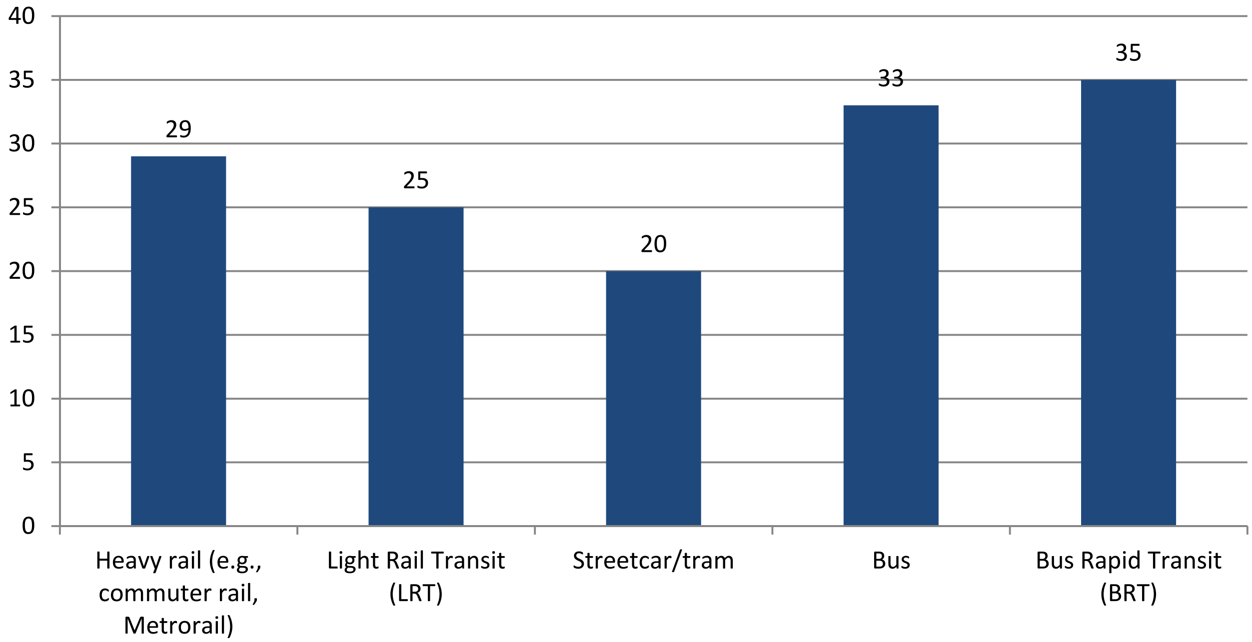


Figure 4.8 Public Transit Applications as Reported by Stakeholders



4.2.2 Non-categorical (open ended) questions

To maintain the confidentiality of the survey respondents for the non-categorical questions and comment fields, the only way to present survey information is to present it in a way where one cannot discern the respondent's identity. Furthermore, it is not possible to include all the open-ended responses received in the survey, so Appendix B presents a selection of responses from only the following two questions:

- Q13: What refinements to the regional travel model would most effectively serve your day-to-day planning needs in the next five years? (Optional); and
- Q14: Are there any other comments or suggestions you would care to make regarding the TPB's model development plans? (Optional).

4.3 TPB Staff Perspective

In addition to stakeholder input that was obtained from the survey of stakeholders, TPB developed a list of issues important to the region from their perspective. As the model developer, caretaker, and entity responsible for the long range plan and annual air quality conformity analysis, TPB has an important perspective to consider. TPB staff work with the model frequently and their analyses rely heavily on its output.[17] Table 4.1 views this list through the lens of informing a strategic plan (i.e., Cambridge Systematics adapted the list for presentation in this context).

[17] November 26, 2014 memorandum from TPB staff, Revised proposal for developing a strategic plan for models development, Task Order 2 of FY 2015, under COG Contract #14-056, Assistance with the development and application of the MWCOG/NCRTPB travel demand model.

Table 4.1 TPB Staff Perspective on Modeling Issues

Higher-Priority Modeling Issues
1. Determining how much effort should be spent moving to advanced models (e.g., ABM, DTA, land use models) versus updating the existing trip-based, four-step model
2. Highway assignment – trade-offs between model run time and convergence
3. Evaluating high-occupancy vehicle (HOV) and high-occupancy toll (HOT) lanes – Would advanced models better address this issue?
4. Improving transit representation:
Current model deals with only internal-to-internal trips, but external transit trips occur in this region
Production/Attraction versus Origin/Destination evaluation
Uncongested versus congested assignments (i.e., handling core capacity issues)
5. Refining mode choice modeling:
a. Should there be separate branches for the items listed below?
i. Treat toll versus nontoll as choice in the mode choice model?
ii. Add transit submodes (e.g., LRT, BRT, streetcar) to the model?
iii. Add nonmotorized choice(s) to the mode choice model? Currently, nonmotorized trips are handled in the trip generation stage.
b. Streamline market segmentation – Use more limited segmentation, potentially facilitating through new land use or other environment variables.
c. Update estimation/calibration/validation
i. After migration to the new transit path-building software (PT), TPB staff plan to recalibrate the mode choice model, but have not yet determined whether to perform a statistical estimation or to simply adjust the alternative specific constants.
ii. What datasets should be used/combined and what issues are introduced if we combine datasets, such as a household travel survey and one or more on-board transit surveys?
6. Adding explicit treatment of visitor/tourist travel.
7. Introducing version control software and bug/issue-tracking software
Lower-Priority Modeling Issues
1. Considering changes to land use inputs, such as the use of a land use model
2. Updating freight modeling

5.0 Other Stakeholder Input

During the conduct of this study, there has been other stakeholder input regarding the travel model, principally from WMATA, the region's largest transit operator, responsible for operating both Metrorail and Metrobus. Although WMATA is not a direct user of the regional travel demand model, it makes use of the model outputs and uses consultants who run, and modify, the model for various studies. Consequently, WMATA has various ideas about improvements that can/should be made to the model. WMATA completed the stakeholder survey, including adding comments to some of the non-categorical questions in the survey. Appendix B of the report includes comments from WMATA, though, for confidentiality reasons, comments have not been attributed to individuals. Additionally, WMATA staff sent a letter to the chair of the TPB requesting that various changes be made to the regional model.[18] COG/TPB staff responded to WMATA with a letter,[19] which was then followed-up with a meeting on February 11.[20] This information will be considered in the development of the strategic plan (Report 3 of 3) and in subsequent implementation efforts.

6.0 Next Steps

This task report has provided coverage of potential opportunities for improving the current COG/TPB model. These opportunities draw from the prior consultant recommendations, the review of best practices, and the issues and necessary improvements identified by the various stakeholder inputs that were solicited. The strategic plan must consider these opportunities in outlining a path forward to enhancing the COG/TPB model over the next several years.

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[18] Kannan to Wojahn, October 30, 2014.

[19] Ronald Milone to Shyam Kannan, Letter, (December 3, 2014), "Item 5 - Letters Sent and Received," from the Dec. 17, 2014 meeting of the NCRTPB, http://www.mwcog.org/uploads/committee-documents/bF1XXF1c20141211093433.pdf.

[20] Mark S. Moran to Ronald Milone et al., "Meeting Summary and Points of Agreement from the February 11, 2015 Meeting between WMATA and COG/TPB Staff Regarding Transit-Related Improvements to the COG/TPB Regional Travel Demand Model," Memorandum, (March 2, 2015).

Appendix A. TPB Stakeholder Survey

COG/TPB staff is working with Cambridge Systematics, Inc. to develop a multiyear strategic plan for the COG/TPB models development program. The plan will consider the current and future needs of the travel modeling community in the Washington, D.C. region. The survey is intended for professionals who are reasonably familiar with the TPB travel model and/or are users of model-related data. The survey includes 15 questions and should take about 15 to 20 minutes to complete. Responding to our survey will ensure that opinions are considered in the development of the strategic plan. Multiple surveys may be submitted from a single agency/firm. Your individual responses will be kept confidential, but we will release aggregated findings upon request. Questions about this survey should be directed to Mark Moran, Principal Transportation Engineer, Metropolitan Washington Council of Governments, mmoran@mwcog.org. If you would like to save a copy of the survey and your responses, you may do either or both of the following: 1) print each page after you have filled it in; and 2) provide your email address at the end of the survey and a copy will be sent to you in less than 2 minutes.

1. Please provide the following information:
   Respondent's Name (optional):
   Respondent's Position/Title:
   Respondent's Years of Experience in Travel Modeling (numerical value):

2. Agency/Company Type:
   - ❍ Federal Agency
   - ❍ State DOT
   - ❍ Transit Operator (e.g., WMATA, Ride-On, ART)
   - ❍ Regional Agency (e.g., MWAA, NVTC, NVTA)
   - ❍ COG/TPB staff
   - ❍ County DOT/Planning Agency (includes M-NCPPC)
   - ❍ Local Government
   - ❍ Consultant
   - ❍ University/Academic
   - ❍ Other ____________________

3. Agency Name (optional):

4. Have you executed the adopted TPB travel model during the past three years?
   - ❍ Yes
   - ❍ No

5. Have you used TPB travel model inputs or outputs during the past three years?
   - ❍ Yes
   - ❍ No

6. What types of projects have you undertaken in the past three years? (Check all that apply)
   - ❑ Regional planning
   - ❑ Corridor/subarea studies
   - ❑ Land development studies
   - ❑ Transit "New Starts" studies
   - ❑ Transit non-"New Starts" study
   - ❑ Air quality planning
   - ❑ NEPA
   - ❑ Scenario analysis
   - ❑ Highway microsimulation
   - ❑ Toll road analysis
   - ❑ Other (please specify) ____________________

7. What was the geographic level of analysis of the studies you have worked on in the past three years? (Check all that apply)
   - ❑ Regional level
   - ❑ Subregional level
   - ❑ Jurisdiction level
   - ❑ Corridor level
   - ❑ Regional activity centers
   - ❑ Project impact area level
   - ❑ Zone (TAZ) level
   - ❑ Sub-zone level
   - ❑ Parcel level
   - ❑ Intersection level

8. Please select the transportation modes that were the focus of studies that you have conducted over the past three years. (Optional, but check all that apply)

8a. Nonmotorized
   - ❑ Walk
   - ❑ Bike

8b. Motorized – Public Transportation
   - ❑ Heavy rail (e.g., commuter rail, Metrorail)
   - ❑ Light Rail Transit (LRT)
   - ❑ Streetcar/tram
   - ❑ Bus
   - ❑ Bus Rapid Transit (BRT)
   - ❑ Other

8c. Motorized – Private Transportation
   - ❑ Cars/automobiles (general)
   - ❑ HOV, HOT-lane, and/or tolling
   - ❑ Trucks
   - ❑ Commercial vehicles
   - ❑ Other

9. Please indicate the level of interest in your agency (or for your clients) regarding the following transportation policy issues.

	1No Interest	2Low Interest	3Medium Interest	4High Interest	5No Opinion
Fair accessibility and mobility	○	○	○	○	○
Provision of multimodal options	○	○	○	○	○
Effective system management	○	○	○	○	○
System maintenance	○	○	○	○	○
Environmental protection	○	○	○	○	○
Land use – transportation coordination	○	○	○	○	○
Adequate funding and cost effectiveness	○	○	○	○	○
Reducing traffic congestion	○	○	○	○	○
Increasing regional accessibility	○	○	○	○	○
Reducing crowding on transit	○	○	○	○	○
Exploiting technology	○	○	○	○	○

10. Please indicate your level of satisfaction with the current regional travel demand forecasting process in the following areas.

	1Very Dissatisfied	2Dissatisfied	3Neutral	4Satisfied	5Very Satisfied	6No Opinion
Model run time	○	○	○	○	○	○
Model's ease of use	○	○	○	○	○	○
Model's adaptability	○	○	○	○	○	○
Model development	○	○	○	○	○	○
Model documentation	○	○	○	○	○	○
Model inputs (networks and/or land activity)	○	○	○	○	○	○
Model outputs	○	○	○	○	○	○
Software used to apply the model	○	○	○	○	○	○
Technical support	○	○	○	○	○	○
Calibration/ validation data	○	○	○	○	○	○
Model's accuracy/ precisions of estimate	○	○	○	○	○	○
Overall level of comfort	○	○	○	○	○	○

11. In your opinion, how well does the current regional travel demand forecasting process address the following traditional transportation issues?

	1Not Addressed	2Poorly Addressed	3Somewhat Addressed	4Well Addressed	5No Opinion
Congestion pricing/managed lanes	○	○	○	○	○
Mobile source pollution analysis	○	○	○	○	○
Highway pricing (fuel, parking)	○	○	○	○	○
Travel demand management	○	○	○	○	○
Transit-oriented development	○	○	○	○	○
Transit fare policy	○	○	○	○	○
Land use scenarios	○	○	○	○	○
Site/development impacts	○	○	○	○	○
Transit projects and service improvements	○	○	○	○	○
Roadway projects and network enhancements	○	○	○	○	○
Transit submode analysis	○	○	○	○	○
Competition among/choice of travel modes	○	○	○	○	○
Other (please specify) (If none, select "No Opinion" and add "NA" in text box)	○	○	○	○	○

12. In your opinion, how important is it for an updated TPB regional travel demand forecasting process to address the following emerging transportation issues?

	1Very Unimportant	2Unimportant	3Neutral	4Important	5Very Important	6No Opinion
Travel behavior for specific population segments	○	○	○	○	○	○
Peak spreading	○	○	○	○	○	○
Scheduling of household activities	○	○	○	○	○	○
Environmental sustainability	○	○	○	○	○	○
Effect of Internet on travel behavior	○	○	○	○	○	○
Emerging transportation modes (e.g., connected vehicles, autonomous vehicles)	○	○	○	○	○	○
Traffic microsimulation	○	○	○	○	○	○
Greenhouse gas analysis	○	○	○	○	○	○
Equity concerns	○	○	○	○	○	○
Infrastructure condition	○	○	○	○	○	○
Telecommuting	○	○	○	○	○	○
Freight planning	○	○	○	○	○	○
Travel time reliability	○	○	○	○	○	○
Transit crowding	○	○	○	○	○	○
Uncertainty in model outputs	○	○	○	○	○	○
Other (please specify) (If none, select "No Opinion" and add "NA" in text box)	○	○	○	○	○	○

13. What refinements to the regional travel model would most effectively serve your day-to-day planning needs in the next five years? (Optional)

14. Are there any other comments or suggestions you would care to make regarding the TPB's model development plans? (Optional)

15. Please choose:
    - ❑ I would like to be emailed a copy of my survey responses.
    - ❑ I would like to be notified when study findings are available.

    If you checked either box, please provide your email below.

    Please retype your email.

    Questions? Contact Mark Moran, Principal Transportation Engineer, Metropolitan Washington Council of Governments, mmoran@mwcog.org

Appendix B. Open Ended Comments (Stakeholder Survey)

To maintain the confidentiality of the survey respondents for the non-categorical questions and comment fields, the only way to present survey information is to present it in a way where one cannot discern the respondent's identity. Furthermore, it is not possible to include all the open-ended responses received in the survey, so this Appendix presents a selection of responses from only the following two questions:

- Q13: What refinements to the regional travel model would most effectively serve your day-to-day planning needs in the next five years? (Optional); and
- Q14: Are there any other comments or suggestions you would care to make regarding the TPB's model development plans? (Optional).

The comments have been grouped into categories, but this can be challenging, since some comments relate to multiple categories.

B.1 Data

"The models development plan must allocate ample funding for the data needed to support it."

"Greater use of HH panel data to try to match actual changes in behavior over time (more than just a 'snapshot')."

B.2 Model inputs (networks, land use)

"Basic verification of network links and land use data would be most effective. It is difficult to trust model outputs when we very regularly find errors in network coding or land use."

"We find that much of our network at the county level [is] not complete" or tends to miss road links that we consider important.

"More coordination with our office in terms of coding centroid connectors, links, etc."

"Improvements to highway network representation"

"Retaining the [traffic] count data on the link that was used for validation."

B.3 Model implementation issues

"Clean up file naming and use Cube standard names (i.e. *.lin versus *.TB)"

"Reduction of run time" (mentioned by several respondents)

"Adaptability to sub-area travel demand modeling"

"Fewer input files" (mentioned by a few respondents)

"Migration... from batch file based process."

"1) Application (scenario) management system; 2) Flexibility of model application: allowing running individual model elements easily and separating process for regional project planning and localized project planning process (which may not need to run the entire model process or the feedback); 3) Enhancement of post-model process, such as: summarizing various mobility/accessibility measures by subarea/jurisdiction or summarizing transit station line/ station volumes by time period; and 4) Reduce model run time"

"The run time and the number of iterations as well as the complexity has made it harder to use the tool as an effective planning instrument."

"User friendly application/interface with shorter run time and a better resolution of TAZ and includes finer transit details for specific transit analysis projects. The regional model could also have sub-models by county/jurisdiction for regional as well as localized analysis by local jurisdictions. An example is the FSUTMS model (Florida)."

"Having worked with the TPB model since it was in MINUTP, I personally like the DOS batch file setups. I think it makes it easy to review the model process and locate individual scripts when reviewing the model setups and parameters. I have a hard time envisioning how packaging the model in Cube catalog would make the model easier to use if that were a consideration, but this is just my personal opinion."

"I would like to see the input process redefined. There are too many separate files which can be hard to trace back in the toll definition. I understand the reason is to be flexible, but if you miss one, the toll is applied in the network attribute, but may not be used in the assignment process. With Excel not supporting the output of DBFs, creating and modifying the DBF inputs can be frustrating."

"Migrate entire model platform to Cube [Application Manger?] should be the initial starting point for the model improvement process. This will make the model much more flexible and transparent for users."

B.4 Model calibration/validation

"Calibration and validation to more recent travel patterns; Validation of model to operational speeds (to the extent possible)."

"Better validation of the transit ridership."

"Will you consider comparing historic model outputs against actual outcomes, to better understand model strengths and weaknesses, and to enhance future forecasts?"

B.5 Model documentation, training, and support

"Support, documentation and openness is excellent"

"I have an interest in the TPB to provide more detailed technical services/assistance. This would require the TPB to provide the resources to do so and perhaps this could be financed by contributions from the local jurisdictions and agencies."

B.6 Aggregate trip-based models versus disaggregate activity-based models

"While it would be nice to pursue a state of the practice model, it is much more important to pursue a model which better represents the network and land use."

"Research should begin on an ABM, but very slowly."

"Don't get fancy -- focus on getting the basics right. / Agree with not being in a hurry to switch to ABM."

"Switch to activity based model within five years, work with surrounding counties to consolidate work effort."

"I recommend considering dynamic traffic and transit assignments before pouring a lot of money into activity-based demand models."

"The four-step model serves the region's needs fairly well. Do not jump into the activity based model quicksand. You may want to consider upgrading trip generation to be tour-based without continuing with the rest of the activity based modeling process."

"I think the general trend of more detailed models (and therefore slower run times and more complexity) is missing the point of a regional model."

"If you migrate to Activity-based modeling, will this include alternate land use scenarios?"

B.7 Mode choice

"Total revamp of the mode choice application."

"Integration of pedestrian environment factors."

Re-estimate/re-calibrate mode choice model after migrating from TRNBUILD to PT

B.8 Non-motorized modeling

"Improve non-motorized travel representation"

"Non-motorized mode (walk and bike) should be added to the mode choice model"

"Method for quantifying differences in walkability within a zone/station area."

"Walk to transit access and non-motorized transportation."

B.9 Transit modeling

"Convert to PT networks"

"Provide better transit outputs and utilities"

Interest in making the regional travel model more FTA compliant

"Customize travel demand model so that it is acceptable for FTA New Starts project forecast. [state agency] used a customization of COG 2.2 forecasting model that had been accepted by FTA for [a] streetcar project."

"Estimated bus travel times should be dependent on roadway congestion."

"Transit assignment for am/pm peak / - Better transit validation, especially for bus network."

"Include direct transit capacity constraints (with PT?)"

"Bring the heavy rail network into the real network; no need to have virtual links and nodes (8000s, etc.) that makes everything harder to visualize / - The station.dbf input file includes a lot of information that doesn't seem to actually be used."

"Improved calibration and validation of fixed guideway transit and bus corridors with particular focus on reproducing OD travel patterns for transit users."

"More realistic consideration of transit access/egress options."

"Include better methods of capturing the differences between LRT, BRT, streetcar and bus modes."

"Consider the impact of highway congestion on transit services."

"Metrorail and commuter rail ridership by line and time of day."

"Station-level boardings and travel patterns."

"Greater sensitivity to a traveler's choice of transit sub-mode choice (e.g., how well does the model represent one's choice between bus, streetcar, and BRT?)… need better insight into the true differences among modes to better guide decisions. COG/TPB staff noted that calibrating the model without operational data from these modes is very difficult."

"VRE plays a significant role in the region's transportation by running service that provides options along two of the most traveled and congested corridors. [The VRE] long range plan that anticipates infrastructure improvements/expansions that will support doubling ridership by 2040. Refinements to the regional travel model that accurately reflect VRE's ridership and VRE's contribution to the transportation system and air quality of the region are critical to support long range plans and obtaining funding support for the necessary improvements."

"VRE collects and analyzes various types of data for operational and planning purposes... [which could be useful] to support refinements to the model."

"Top priority relates to modeling of transit projects, specifically their impact on traffic congestion levels."

B.10 Modeling road pricing and tolling

"Improved ability to model HOV and HOT-lane facilities"

"More sophisticated toll modelling"

"Improved sensitivity to pricing policies (e.g. HOT lanes)."

B.11 Traffic and transit assignment

"Multi-resolution modeling is not just a trend but is useful in many areas of transportation planning and applications. It would be great to see the model will be improved to have a better meso/microscopic integration."

Consider other traffic assignment algorithms (possibly from other vendors) that would achieve more rapid convergence.

Assign auto-access transit trips to the highway network.

"Test more sensitive traffic assignment tech, e.g., dynamic traffic assignment."

"Assign 4 time periods for transit forecasting, same as the highway forecasting."

"Capability of conducting meso- or micro-scale traffic analyses would have so much potential for intersection impact or project level analyses."

"Dynamic Assignment is some form should be used for all managed/HOT lane analysis. It would be difficult to replace the entire assignment step with a DTA, but major corridors such as I-95 and I-495 could be used as starting points for building a DTA model for region which could be used specifically for dynamic pricing analysis."

B.12 Other comments

Model school trips as a separate trip purpose.

"Align TAZs with those of each county's model"

"Continued refinement of TAZs for communities inside the Beltway (i.e., smaller TAZs)"

"Greater flexibility / consideration for detailed zone and network coding for subareas and corridor studies."

"Trip generation for special facilities such as military bases."

"More explicit treatment of airports as special generators would be helpful."

"Consideration about active and passive peak spreading. Refinements to freight and air passenger component of model."

"Capability to simulate / forecast peak spreading - diurnal conditions. Incorporation of travel time reliability."

"The TPB model should be employed to address regional issues, not local ones. Improvements should focus on its capabilities to address regional and sub-regional policy issues, not localized conditions such as site impact studies and traffic operations through microsimulation."

"Incorporation of travel trends, such as for vehicle miles traveled, in the model. There was a general discussion of how long trends need to be observed before they can be added to the model. COG/TPB staff does not feel that the short duration of VMT reduction can be added quite yet, as it is not clear if it is due to the economic downturn or lifestyle choices that will continue (e.g. Millennials)."

"Modeling over-saturated conditions, long term destination and behavioral choices and impacts due to congestion, reliability and technology in future years. Model sensitivity to analyze multimodal policies and projects."

"Since a lot of my work is focused on corridor studies and site impact analysis, two challenges we regularly [face] are zone splitting and the time required to run multiple scenarios. Perhaps the development of an integrated subarea extraction process would make it easier to perform focused study area analysis."

"Addressing peak spreading. On very congested facilities such as the Capital Beltway - we are already near peak hour saturation and it is challenging to forecast peak hour volumes in future years."

"Provide a guide to assist users in zone-splitting, as this is warranted when performing corridor and land use studies."

"It is good to see that current and emerging issues are being considered during this stage of model development, although it may be difficult to address many of these issues. Currently, there is an emphasis on evaluating multimodal projects against a range of performance measures that go well beyond congestion management and air quality. In Northern Virginia, this includes the HB-599 and HB-2 efforts. It is possible that the COG model could form a foundation for attempting to quantify additional benefits of projects in the future, and be used for purposes beyond those currently established for the model."

"Incorporate travel time reliability (highway for now) into travel demand models if it is possible."

"[The capability to model] Integrated Corridor Management projects to include freeway Active Traffic Management, parallel arterial routes, feeder routes, and transit."

"How will you Integrate recommendations from GHG subcommittees?"