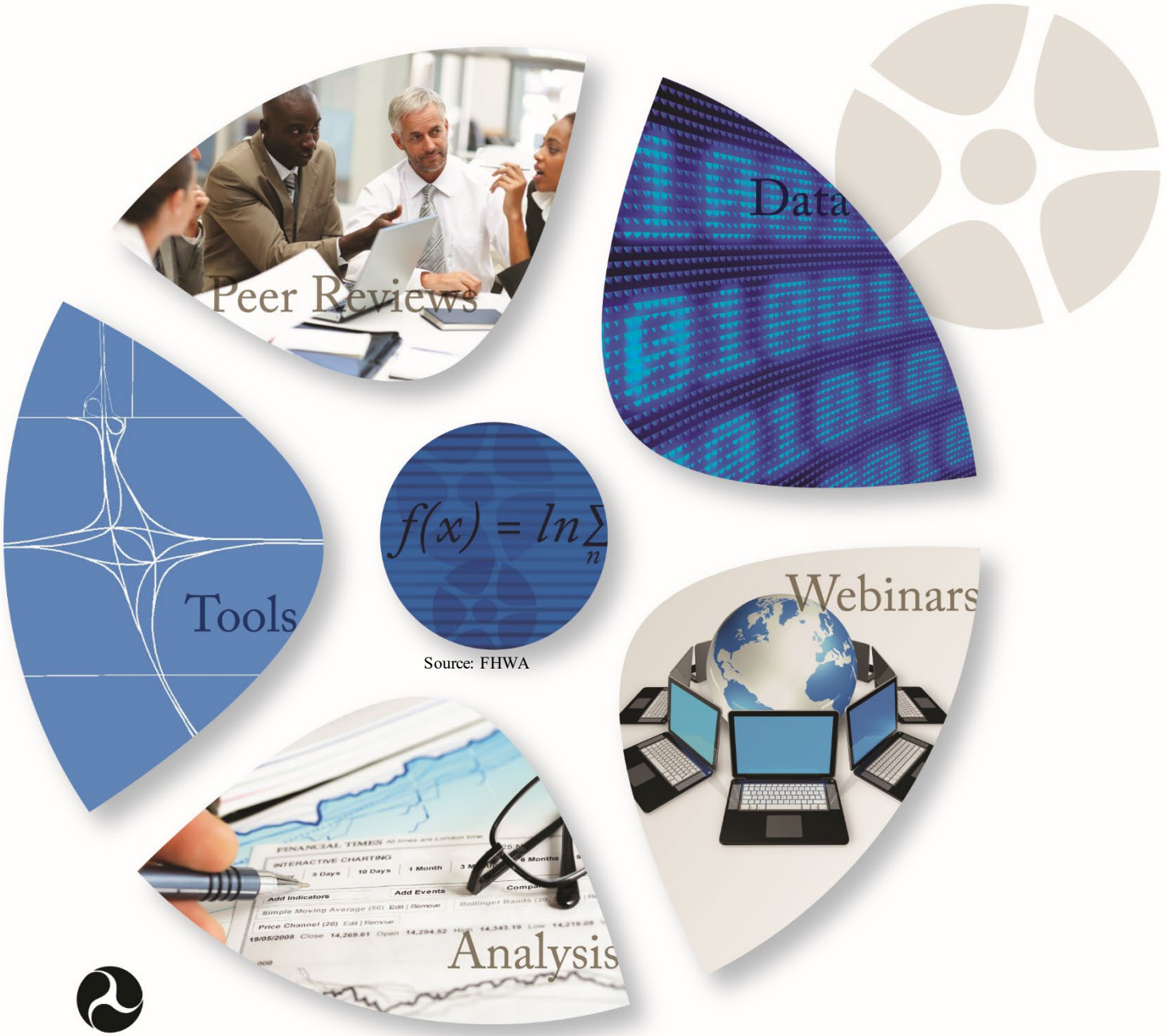
A Snapshot of Travel Modeling Activities: 2023 Update

JANUARY 2024



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FHWA-HEP-24-018

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16. Abstract

This report updates the information compiled and presented in the 2008 report, "A Snapshot of Travel Modeling Activities." The purpose of the original 2008 report was to summarize the use of travel demand models by five metropolitan planning organizations (MPOs) identified by the Federal Highway Administration (FHWA) based on their recognized leadership in the industry and a history of using travel forecasts generated by travel demand models to support the development of regional plans. An addendum to the original 2008 report was developed in 2011 to demonstrate MPOs' progress on modeling goals, developments, and future plans. The purpose of undergoing an update in 2023, 15 years later, was to check in with the original MPOs, as well as one additional MPO, to learn about their progress in advancing travel modeling tools and applying them in the planning process. The 2023 report update provides an opportunity to assess these MPOs' progress in advancing their travel modeling tools and applying them in the planning process. Both the 2011 and 2023 interviews were conducted virtually, while the 2008 interviews were conducted in person. This report serves as the "2023 update" to the original 2008 report and the 2011 addendum. This update is intended to supplement, not replace, the two previous reports.

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Approximate Conversions to SI Units				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
Length				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
Area				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
Volume				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
Mass				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
Temperature (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
Illumination				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
Force and Pressure or Stress				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

Approximate Conversions from SI Units				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
Length				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
Area				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
Volume				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
Mass				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
Temperature (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
Illumination				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
Force and Pressure or Stress				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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List of Abbreviations and Symbols

Abbreviations

ARC	Atlanta Regional Commission
AV	Autonomous/Automated Vehicles
BRT	Bus rapid transit
CEMDAP	Comprehensive Econometric Microsimulator for Daily Activity-travel Patterns
CEMSELTS	Comprehensive Econometric Microsimulator of Socioeconomics, Land Use, and Transportation Systems
CMP	Congestion Management Process
COTA	Central Ohio Transportation Authority
CT-RAMP	Coordinated Travel Regional Activity-Based Modeling Platform
DOT	Department of Transportation
DTA	Dynamic Traffic Assignment
EIS	Environmental Impact Statement
EV	Electric Vehicles
FHWA	Federal Highway Administration
GDOT	Georgia Department of Transportation
GTFS	General Transit Feed Specification
HPMS	Highway Performance Monitoring System
LRTP	Long-range Transportation Plan
MORPC	Mid-Ohio Regional Planning Commission
MPO	Metropolitan Planning Organization
NCTCOG	North Central Texas Council of Governments
NEPA	National Environmental Policy Act
NYBPM	New York Best Practice Model
NYMTC	New York Metropolitan Transportation Council
ODOT	Ohio DOT
PSRC	Puget Sound Regional Council
RITIS	Regional Integrated Transportation Information System
RTM	Regional Travel Model
RTP	Regional Transportation Plan

SED	Socioeconomic and Demographic
SHRP	Strategic High Research Program
State DOT	State Department of Transportation
TDM	Travel Demand Model
TIP	Transportation Improvement Program
TMIP	Travel Model Improvement Program
TNC	Transportation Network Company
TRB	Transportation Research Board
VHT	Vehicle hours of travel
VMT	Vehicle miles traveled

1.0 Executive Summary

1.1 Purpose of 2023 Update

In August 2008, the Federal Highway Administration (FHWA) published "A Snapshot of Travel Modeling Activities" ("2008 report"). The 2008 report sought information on the use of travel demand models (TDMs) by five Metropolitan Planning Organizations (MPOs) in the transportation planning process. This report serves as the "2023 update" to the original 2008 report and an addendum completed in 2011. FHWA looks to support MPOs and State Departments of Transportation (State DOTs) to enhance the application of travel demand forecasting in the transportation planning process, such as through the development of resources or performance metrics for travel demand modeling and sharing best practices for navigating evolving technologies and emerging issues. This 2023 update is intended to supplement, not replace, the 2008 report and 2011 addendum. The 2023 update aims to help FHWA:

- Assess the state of the practice and identify how it has evolved since 2008;
- Identify gaps/improvement areas for new travel demand forecasting techniques; and
- Gain potential insight of the cost for MPOs to implement various forecasting techniques, including by agency size and need.

1.2 Progress in Implementing Activity-Based Modeling

The 2008 report and 2011 addendum documented the MPOs' progress in adopting an activity-based model. Most MPOs participating in the 2023 update have since adopted an activity-based model, including ARC, PSRC, and MORPC.

- **Atlanta Regional Commission (ARC)** adopted an activity-based model in 2010. The ARC model is based on the CT-RAMP (Coordinated Travel Regional Activity-Based Modeling Platform) family of activity-based models. The agency is transitioning to using ActivitySim[1] at the time of the 2023 update.
- **Mid-Ohio Regional Planning Commission (MORPC)** had an activity-based model in place as of the time of writing the 2011 addendum. MORPC uses an advanced activity-based model, which includes CarTracker for auto ownership and accessibility data.
- **North Central Texas Council of Governments (NCTCOG)** uses a trip-based model. NCTCOG is considering enhancing the network modeling part of the travel model, using both transit and roadway time-dependent network modeling. NCTCOG also plans to improve the travel model using an existing agent-based model[2] rather than developing a new one.

[1] The ActivitySim software is developed and maintained by a group of planning agencies and made available under an open-source license.
[2] Agent Based Modeling and Simulation (ABMS) is a modeling approach for simulating the actions and interactions of autonomous individuals, with a view to assessing their effects on the system as a whole.

- The **Puget Sound Regional Council (PSRC)** was in the progress of adopting an activity-based model as of the time of writing of the 2011 addendum. PSRC has adopted an activity-based model and uses DaySim. The MPO is in the process of developing an open-source ActivitySim, which has a community where members contribute to model development.
- A new participant to the 2023 update, **New York Metropolitan Transportation Council (NYMTC)**, uses the New York Best Practice Model (NYBPM), an activity/tour-based model capable of working for the purpose of policy and planning development evaluations. Using TransCAD capabilities and customized programs, a regionwide transit system is built using General Transit Feed Specification (GTFS) data and transit skims are obtained to be used as inputs into the TDM system.

All five MPOs have been working to enhance their travel demand models in recent years. ARC, MORPC, PSRC, and NYMTC have been using activity-based models, with two of them having adopted or are exploring the use of ActivitySim. NCTCOG is investigating an agent-based, model concept.

1.3 Role of Travel Demand Modeling in Transportation Planning

Travel demand modeling primarily has been used for forecasting regional travel demand and (for those non-attainment or maintenance areas) conformity determination. As the objectives of transportation planning continue to evolve from simply increasing road capacity and improving level-of-service to managing demand, improving accessibility in the region, and other emerging issues such as climate change, equity, safety and quality of life, the regional TDMs are expected to evaluate a wide range of emerging issues and transportation policies. Some modeling staff at these MPOs have been investigating possibilities of using travel modeling as a tool for more than predicting road capacity needs to address emerging issues. At the time of the interviews, all investigation by the MPOs was still at the informal research stage.

1.4 Emerging Issues and the Evolution of Tools to Examine Them

Travel demand models continue to improve incrementally to address the challenge of emerging issues and the changing transportation landscape. The 2011 addendum stated that most of the MPOs had only begun to consider the newer policy issues of sustainability, climate change, and livability. In the 2023 update, NCTCOG reported using the regional travel demand model for an assessment of rainfall scenarios and runoff management. NYMTC indicated that their travel demand models are used to plan evacuation routes. More recently, PSRC has used SoundCast to analyze what policy and planning actions could help the region meet its climate goals.

New challenges and opportunities affecting transportation planning have emerged in the past decade, such as the COVID-19 pandemic, equity, and emerging technology. The MPOs interviewed responded to COVID-19 in various ways. ARC incorporated telecommuting into the model to address the large shift of office workers away from physical office space. PSRC conducted Regional Transportation Plan (RTP) analyses throughout the COVID-19 pandemic. PSRC did not consider this a normal time reference point and used 2018 data. PSRC utilized return-to-work scenarios that the University of Washington developed for the region. PSRC is now moving to 2023 as a “new normal” baseline.

Communities across the country seek strategies to increase equity in their regions. ARC has completed equity analyses off-model, through post-processing with the output from the ARC activity-based model. At MORPC, the TDM is used to do environmental justice analysis for the National Environmental Policy Act (NEPA) program.

Technology has advanced since the 2011 addendum in terms of "big data" and advances in transportation technology. Big data is a new topic in the 2023 update, and the MPOs interviewed provided different perspectives on its use. NYMTC used big data for monitoring trends and defining potential future conditions. MORPC indicated concern about the reliability of the data. Therefore, MORPC used big data sources with great care and caution since the reliability of the data can still be hard to gauge. At PSRC, there was no budget for big data subscriptions.[3]

The MPOs were asked about their models' ability to address emerging technology. NCTCOG used scenario analysis and model improvements to address electric and autonomous vehicles (EVs and AVs).

1.5 Incremental Approaches to Improve Travel Demand Models

The 2011 update identified an ongoing theme among the MPOs to be continual model improvement to address emerging issues and uncertainty. The MPOs were asked if they considered employing new travel demand modeling methods. MORPC believed they already have a state of art model. The current model is an advanced activity-based model. CarTracker is part of the existing model and is used for auto ownership and accessibility data. NCTCOG stated that the next step is the improvement of the TDM using an existing agent-based model rather than developing a new one. These models will be developed in parallel with the existing regional travel model (RTM) and data collection programs.

The MPOs were asked about strategies to integrate other models to respond to their region's needs. ARC was the only agency who has responded to this question. ARC had an air passenger model and an airport ground choice model.

In addition, the MPOs discussed software to supplement their TDMs. At PSRC, the focus was replacing DaySim with ActivitySim. PSRC was looking at models, like VisionEval, Replica, and BEAM CORE as side research. ARC used VisionEval (from FHWA and a pooled fund). NYMTC has looked at various software supplements as well.

[3] Collaborations or sublicensing with other agencies was not reported by PSRC.

2.0 Research Approach and Report Organization

2.1 Research Process and Scope

This report updates the information compiled and presented in the original 2008 report. The purpose of the 2008 report was to summarize the use of travel demand models by five MPOs identified by FHWA based on their recognized leadership in the industry and a history of using travel forecasts generated by travel demand models to support the development of regional plans. An addendum to the original report was developed in 2011 to demonstrate MPOs' progress on modeling goals, developments, and future plans. The purpose of undergoing an update in 2023, 15 years later, was to check in with the original MPOs, as well as one additional MPO, to learn about their progress in advancing travel modeling tools and applying them in the planning process. The 2023 report update provides an opportunity to assess these MPOs' progress in advancing their travel modeling tools and applying them in the planning process. Both the 2011 and 2023 interviews were conducted virtually; FHWA conducted the 2008 interviews in person.

To inform the 2023 update, each of the original five MPOs was invited to validate their responses from the 2008 report in addition to answering new questions FHWA developed. New questions covered topics such as data collection and analysis pre- and post-COVID-19 pandemic, induced travel considerations, equity analysis, and strategies for communicating model outputs to stakeholders. The MPOs participated in discussions to contextualize the current state of their planning and modeling activities.

2.2 Report Participants

Five MPOs, four from previous report iterations and one new MPO, participated in the 2023 report update (Table 1).

- The **Atlanta Regional Commission (ARC)** is the MPO for 20 countries in the Atlanta metropolitan region. Since 2011, ARC transitioned from a four-step to an activity-based model to manage and analyze demographic information. For ARC, model outputs, supplemented by big data, are the driving force for plan updates, project selection, and significant Transportation Improvement Program (TIP) amendments, especially those involving capacity changes.
- **Mid-Ohio Regional Planning Commission (MORPC)** (Columbus, Ohio) is the MPO for central Ohio. The planning region covers Franklin County, Delaware County, and portions of Fairfield, Licking, and Union counties. MORPC utilized an activity- and tour-based travel demand model. Looking forward, MORPC plans to continue with their current model with planned updates in the near- and long-term.
- **North Central Texas Council of Governments (NCTCOG)** (Dallas-Ft. Worth-Denton, Texas) is the MPO for a 12-county area in the Dallas-Fort Worth region. NCTCOG has implemented a trip-based travel demand model. The model was used to project future travel conditions, and outputs are used to inform project selection. NCTCOG has been deliberate in enhancing their travel demand model. The MPO has planned improvements for the demand model using an existing agent-based model.
- The **Puget Sound Regional Council (PSRC)** (Seattle, Washington) is the MPO for the four-county Seattle metropolitan area. PSRC has implemented an activity-based travel

model, but they also have a trip-based model as well. The travel model is primarily used to do regional forecasting for the development of long-range transportation plans.

- The **New York Metropolitan Transportation Council (NYMTC)** is the MPO for New York City, Long Island, and the Lower Hudson Valley. NYMTC uses the NYBPM an activity/tour-based TDM for forecasting. It is used to conduct Conformity Determinations for NYMTC's LRTP and TIP and assess projects in the plan and TIP. It provides measures for the Congestion Management Process (CMP) and facilitates Major Investment Studies. Local studies in the region (sub-regional, corridor analysis, and project level) use the outputs from NYBPM.

2.3 Report Organization

This report is organized into the following subsequent chapters:

- **Findings Summary**
    - **Role of the Travel Model in Transportation Planning:** This section highlights the different ways modeling is integrated into the MPOs' transportation planning and decision-making processes.
    - **Current Travel Modeling and Forecasting Practices:** This section provides details on the travel demand modeling, data management strategies, and other related models.
    - **Workforce and Collaboration:** This section demonstrates the human and financial resources used to optimize modeling performance and capacity.
    - **Emerging Issues:** The travel demand modeling field of practice is constantly adapting to and incorporating emerging issues and data. This section details how the interviewed MPOs manage and mitigate uncertainty in their travel demand modeling; address emerging issues such as resiliency and equity; and, employ big data in their travel modeling and practices.
    - **Conclusion:** This section recaps what has been changed since the 2011 update to the 2008 report.

3.0 Findings Summary

3.1 MPO Study Area Characteristics

The following table details the geographic characteristics of the participating MPOs.

Table 1: MPO Descriptions[4]

Characteristics	ARC	MORPC	NCTCOG	PSRC	NYMTC
Number of Counties	20	2 whole and 3 partial	12	4	10
Area (Square Miles)	5,300	1,100	10,000	6,400	2,440
Population					
2000	4,228,000	1,334,000	5,165,196	3,276,000	12,068,000
2030	6,972,000	1,720,000	9,028,520	4,544,000	13,400,000
Annual Growth Rate	1.70%	0.90%	2.00%	1.10%	0.37% (NYMTC 10-county planning area)
Population/Square Mile	798	1,213	1,013	521	5163
Employment					
2000	2,276,000	810,000	3,191,576	1,760,000	6,419,000
2030	3,849,000	1,150,000	6,497,286	2,498,000	7,432,000
Annual Growth Rate	1.80%	1.20%	1.80%	1.20%	0.53% (NYMTC 10-county planning area)
Major Employers	UPS, Delta Airlines, Home Depot, Coca-Cola, Cox Enterprise, Georgia Pacific	Ohio State Government, Ohio State University	Lockheed Martin, American Airlines, Parkland Health and Hospital, Southwest Medical Center, Texas Instruments	Boeing Corporation, Microsoft, University of Washington	Citi Bank, Metlife, Philip Morris International, American Express, Estee Lauder

[4] These data are accurate as of June 2023.

Eight-Hour Ozone	Maintenance[5]	Maintenance	Severe Nonattainment – 10 Counties – 2008 8-Hour Ozone Moderate Nonattainment – 9 Counties – 2015 8-Hour Ozone Conformity Required	Not a designated area.	NAA
CO	N/A	N/A	N/A	Conformity no longer required	Conformity no longer required
PM_{10}	N/A	N/A	N/A	Maintenance	N/A
$PM_{2.5}$	Attainment	N/A	N/A	N/A	Maintenance[6]

3.2 Role of the Travel Model in Transportation Planning

As transportation planning becomes increasingly holistic, more demands are made to the TDM for various types of policy analyses. The travel model continues to serve as an essential tool and resource in the transportation planning process for the MPOs interviewed since 2011 update.

Transportation Planning Process and Travel Modeling

All five MPOs mostly used travel demand models to forecast future travel demand for their long-range transportation plans (LRTPs) as part of the transportation planning process. The MPOs that are in nonattainment or maintenance areas utilize the travel demand models for transportation conformity determinations as well. The output such as future traffic flow may also assist in the project selection for the MPOs' LRTPs and TIPs. More detailed discussion can be found in the following sections.

Performance Measures

Performance measures vary by MPOs and can include travel time, cost-benefit analysis, access to jobs, distribution of trip types, vehicle miles traveled (VMT), transit boardings, mode share,

[5] A 7-county area of the Atlanta region was designated an "attainment area" as of November 16, 2022, for the 2015 ozone standard.

[6] In December 2012, the U.S. Environmental Protection Agency set a new annual standard of 12 micrograms per cubic meter, tightening the previous 1997 standards of 15 micrograms per cubic meter. By meeting the 2012 standard, the Atlanta region also satisfies the 1997 standard.

severe congestion, system reliability, and more. Some are measured with outputs directly from the travel model, while others are from different analysis methods.

TIP and Travel Demand Modeling

The application of travel modeling in relation to the TIP varies by MPO. NYMTC indicated it assesses projects in the TIP and LRTP using several outputs from the model, including vehicle hours of travel (VHT) and VMT for the base and future year. PSRC reported that the model is used in the LRTP but not the TIP. For PSRC, the TIP selection process is not directly based on modeling because of the nuance in projects and the lack of modeling transparency for a wide audience, and finally, the importance of political feasibility of TIP projects, which is not part of the model.

Policy Decisions

The outputs from the travel model can be a tool for MPO boards and technical committees to understand how different policy decisions can impact people in the region. MORPC stated that the model is a resource in decision-making but not a key tool. Decision-makers in the NCTCOG region requested origin/destination data to understand the impact of policies on travel behavior. NCTCOG stated that decision-makers are generally aware that the travel demand model exists but may vary in their confidence in the product. NCTCOG noted that the level of knowledge varies among policy makers, and they primarily trust the MPO staff to interpret the data for the most part. NYMTC explained that travel forecasts helped to evaluate the environmental impact of projects, such as their effects on air quality and greenhouse gas emissions, providing policymakers the opportunity to consider more sustainable options.

Communicating Model Results to Decision Makers and Other Non-modeling Stakeholders

At ARC, NCTCOG, NYMTC, and PSRC, the MPO board or committee is presented with modeling information and alternatives forecast by the MPOs. For ARC, the modeling results could be a driving force for plan updates and TIP amendments. NCTCOG translates travel demand model results into useful inputs to a planning process through presentations and discussions. At NCTCOG, decision-makers looked to the model to provide projections on the traffic impacts of capital infrastructure improvements in their jurisdictions. NCTCOG stated that the technical tools influence the proposals to the MPO board and their decision-making.

The public attitude toward travel demand modeling may vary by topic. In the NCTCOG region, a few members of the public have questioned the accuracy of the traffic projections, especially when there is a potential capital improvement that directly affects their commute or property.

Communication Tools

The MPOs interviewed used a variety of tools to communicate modeling structure, assumptions, and outputs to non-modeling stakeholders. These may include visual aids, charts, maps, reports, websites, animation, Tableau, or Power BI tools.

Other Applications

Beyond the LRTP, the travel demand model (and the output from the travel demand model) has many other applications for the MPOs interviewed. These may include assisting freight planning,

equity and environmental justice analysis, thoroughfare planning, environmental impact statements (EIS), alternative analysis, transit planning, financial decisions and State-required environmental review. NCTCOG also used their travel model for New Starts.

Travel demand models may be adapted for multiple uses. NCTCOG stated that there should be different models for different accuracies required for the application and cautioned that the models should not contradict each other. For ARC, Georgia's counties adapted the regional model for developing their county transportation plans, coding additional roads, and allowing for better granularity for data.

3.3 Current Travel Demand Modeling and Forecasting Practices

A traditional four-step TDM considers the aggregate numbers of trips made by homogenous groups of households. An activity-based model considers daily travel patterns, or daily tours, of individual household members. This section discusses the MPOs' progress toward implementing activity-based models, technical information about the models, the MPOs' ability to address emerging issues through modeling, and the MPOs' positions on model updates.

Progress in Implementing Activity-Based Modeling

The majority of interviewed MPOs have adopted an activity-based model, including ARC, PSRC, and MORPC (Table 2). PSRC used open source ActivitySim, which has a community where members contribute to model development. The ARC model was based on the CT-RAMP family of activity-based models; however, the agency is transitioning to using ActivitySim. MORPC used an advanced activity-based model, which includes CarTracker for auto ownership and accessibility data.

NCTCOG uses a trip-based model. NCTCOG was deliberate in enhancing their trip-based model. NCTCOG was considering enhancing the network modeling part of the travel demand model, using both transit and roadway time dependent network modeling. NCTCOG also planned to improve the travel demand model using an existing agent-based model rather than developing a new one.

New to the 2023 update, NYMTC used the 2019 NYBPM, an activity/tour-based model capable of working for the purpose of policy and planning development evaluations. The activity-based model components of the NYBPM are CEMSELTS (Comprehensive Econometric Microsimulator of Socioeconomics, Land Use, and Transportation Systems) and CEMDAP (Comprehensive Econometric Microsimulator for Daily Activity-travel Patterns).

Models and Modeling Practices

The travel model software and programs used vary across the MPOs interviewed, including Cube Voyager, INRO-EMME, TransCAD, ArcGIS, customized programs, and open-source software in Python, R and Java. Table 2 provides a summary of existing travel demand models for the five MPOs.

Table 2: Descriptions of Existing MPO Travel Demand Models

Model Characteristics	ARC (2008)	ARC (2023)	MORPC (2008)	MORPC (2023)	NCTCOG (2008)	NCTCOG (2023)	PSRC (2008)	PSRC (2023)	NYMTC (2023)
Model Form	Four-Step	Activity-Based	Activity-Based	Activity-Based	Four-Step	Trip-based	Four-step	Activity-Based	Activity/ Tour-based
Trip Generation	Logit and cross classification based	Logit and cross classification based	Logit	Logit	Cross classification-based	Cross classification production attraction and balancing	Cross classification-based	Logit	Activity generation through several models that are mostly logit in structure
Trip Distribution	Gravity model	Gravity model	Destination Choice	Destination Choice	Gravity Model	Gravity Model	Gravity Model	Destination Choice	Destination Choice
Mode Choice	Nested logit	Nested logit	Multinominal Logit	Logit	Nested logit	Multinominal logit	Multinominal logit	Logit	Several models that are logit structure
Highway Trip Assignment	Equilibrium	Equilibrium	Equilibrium	Equilibrium	Equilibrium	Static user equilibrium	Equilibrium		Static user equilibrium
Time-of-Day Model (Highway Assignment)	Diurnal-direction split factors, four time periods	Diurnal-direction split factors, four time periods	Logit-based time of day choice aggregated to five time periods	Logit-based time of day choice aggregated to four time periods	Diurnal-direction split factors, three time periods	PA to OD conversion	Logit-based time of day choice aggregated to five time periods		Time of day choice modeled on a disaggregate basis through models that are mostly logit in structure, & then aggregated into 4 time periods for assignment
Land Use Model	IPEF/DRAM-EMPAL	IPEF/DRAM-EMPAL	GIS-based allocation model	GIS-based allocation model	DRAM-EMPAL	Locally developed	DRAM-EMPAL	UrbanSim	None
Truck Component	Truck generation, distribution, and assignment based on local data	Truck generation, distribution, and assignment based on local data	Quick Response Freight Model (QFRM)-based	Quick Response Freight Model (QFRM)-based	Truck generation, distribution, and assignment based on local data	3-step trip-based model	Truck generation, distribution, and assignment based on WSDOT FASTruck Model	Uses	Trip based model. uses FAF data to estimate truck trips > 50 miles, & QRFM based method for < 50 miles
Freight Model	Yes	Yes	QFRM-based	QFRM-based	No	None	Based on WSDOT FASTruck Model		Truck component includes short & long distance trucks, & commercial vehicles
HOV Analysis	Yes	Yes	Yes	Yes	Yes	A part of the traffic assignment and mode choice	Yes	Yes	Yes. Has HOV lanes & modes
Toll Analysis Capability	Yes	Yes	Yes	Yes	Yes	A part of the traffic assignment model	Yes	Yes	Yes

Time-Dependent Network Modeling

In 2008, ARC, MORPC, NCTCOG, and PSRC acknowledged that a dynamic traffic assignment (DTA) or microsimulation model would be needed to fully capture time-dependent network routing. Since then, microsimulation and DTA models have become more widely available, but are typically used for specific projects, not for long-range planning. At the time of the 2023 update, none of the interviewed MPOs reported currently having a DTA. PSRC mentioned that Washington State DOT has a DTA model.

Since the 2011 update, traffic data has also become more widely available at a fine-grained temporal resolution. In addition to using INRIX raw data, ARC utilized the RITIS (Regional Integrated Transportation Information System) Probe Data Analytics Suite as a means of determining the extent and severity of recurring congestion. ARC also had a trend map tool that allows the agency to show changes in congestion for specific time periods and at various granularities. The tool can rank congestion locations over long periods of time and highlights the location with the greatest impact.

Calibration and Validation Data and Frequency

A big challenge, mentioned by NCTCOG, is the quality of the data upon which models can be built. Although travel surveys remain infrequent and expensive, other sources of trip and volume data are emerging. MPOs use numerous sources to calibrate and validate the travel model. The most prevalent sources among the interviewed MPOs are traffic counts, transit surveys, and household travel surveys. Other data sources include U.S. Census American Community Survey data, speed data, socioeconomic and demographic (SED) data, big data, and origin/destination flow data.

Given the complexities of the New York City region (e.g., high transit use and a significant number of visitors), NYMTC noted it is currently developing a systematic, comprehensive validation plan for the 2019 NYBPM as a part of their regular model validation cadence. The following table presents the responses from the interviewed MPOs regarding model validation frequency.

Table 3: Responses Regarding Model Validation Frequency

ARC	*Agency did not report their validation frequency.*
MORPC	The model is validated every time an LRTP is developed.
NCTCOG	Almost every five years or when later data becomes available.
NYMTC	The model is validated every time an LRTP is developed.
PSRC	*Agency did not report their validation frequency.*

The MPOs were asked if there are any surveys planned. PSRC planned to conduct their household travel survey in 2023. NCTCOG had several surveys that are planned for 2025, including their household, workplace, and external surveys. The NCTCOG on-board survey was completed in 2023. NYMTC was also planning their next household travel survey.

Run Times

The length of time that model runs take vary among the interviewed MPOs from 15 hours up to 48 hours. The following table presents the responses from the interviewed MPOs.

Table 4: Responses Regarding Length of Run Times

ARC	A single global iteration can take 3-4 hours. A convergence can take approximately 20-24 hours.
MORPC	The length varies depending on model year. Overnight (up to ~27 hours) is considered acceptable. Base year can reach the proper convergence overnight.
NCTCOG	About 15 hours to converge with five feedbacks the relative gap in traffic assignment is 1/10,000.
NYMTC	A full run of the model takes more than 24 hours.
PSRC	If all steps are run, the model takes approximately one weekend to run.

Cloud Computing

The MPOs were asked if they were using cloud computing, and the responses varied. A hybrid approach to using the cloud and investing in internal servers has been beneficial to PSRC. NYMTC noted that cost is a barrier to full adoption of cloud computing resources.

Assessing Accuracy

The MPOs interviewed do not have systematic plans to assess travel forecasting accuracy. Time constraints and the 20-30-year time horizon of forecasts were cited as common challenges for assessing accuracy. NCTCOG noted that the users examine the model for accuracy almost every time they use it. When asked about when and how often they assess travel forecasting for accuracy, NYMTC reported that they review the model at least once a year, in parallel with conformity review.

Updating the Model

The MPOs interviewed were asked if they are considering updating their model or employing a new travel forecasting method. For the immediate future, none of the MPOs interviewed had a plan to use a new travel forecasting method. NCTCOG considered enhancing the network modeling part of the regional travel demand model and then using an existing agent-based model rather than developing a new one. For NCTCOG, the factor motivating an update is to improve accuracy. ARC noted they currently use ActivitySim and CUBE Voyager but are working with the Georgia DOT (GDOT) and currently looking at some other options (e.g., DTA). PSRC's focus was replacing DaySim with ActivitySim. NYMTC was integrating the Tourcast platform into their tour/activity-based model.

In the longer term, NCTCOG reported that a model update could be warranted based on a number of factors including policy, new technology, or travel behavior changes. MORPC noted model updates can occur when there is a new, significant development in the region.

Beyond the travel demand model, some of the interviewed MPOs have other models as part of their suite of tools to support regional transportation planning, including land use forecasting, strategic, and airport models. ARC adopted a strategic model (i.e., VisionEval), which is a

separate application from the activity-based model and does not have a coded network. In the 2000s, ARC experienced air quality issues. As a result, one recommendation was to create an air passenger model and an airport ground choice model. ARC reported these models are currently maintained and updated.

PSRC has also considered additional models to address different needs, including vehicle type, telecommuting, and how to incorporate racial equity. PSRC is looking at several other models as side research to supplement existing models. For example, PSRC has been in discussion with staff at King County Metro, which is testing Replica[7], a commercial national travel demand model. According to PSRC staff, even though it is also a disaggregated model, it appears to have good user interface (UI). The Replica software is fast and can be used for short-term analysis. As part of informal research, PSRC is involved in a project (mainly for data sharing) with other stakeholders (including the developers of BEAM[8]) to implement for the region in the future. PSRC is also looking into VisionEval[9] as part of informal research as well.

Land Use Models

MPOs use land use models to understand future growth demands. For example, PSRC assumed future land uses based on policy and planning at a jurisdictional level. The land uses were allocated using the UrbanSim parcel-based land use model. PSRC has a land use technical committee with planners and demographers from jurisdictions around the region, and they are charged with reviewing the model results. NCTCOG has adopted a locally developed land use and demographic allocation model. The agency develops the inventory and the forecast, and local governments review and provide inputs. NYMTC does not currently use a land use model. At MORPC, land use forecasting has been performed using a GIS-based allocation model developed by the MPO, which allocates future households and jobs to a quarter mile grid.

3.4 Resources, Workforce and Collaboration

When it comes to resources allocated to modeling and collaboration with their local and State agencies, each interviewed MPO has its own unique challenges.

Support for Travel Demand Modeling

The interviewed MPOs face challenges regarding funding, data and staffing. At ARC, the challenge was having enough funding or data, especially surveys that are adequate for the travel demand modeling work. MORPC has experienced staff turnover and is faced with training new staff on the travel demand model. Table 5 shows typical annual support for travel demand modeling and transportation planning.

[7] Replica
[8] Behavior, Energy, Autonomy and Mobility – Comprehensive Regional Evaluator (BEAM-CORE) from the U.S. Department of Energy.
[9] VisionEval

Table 5: Average Annual Support for Travel Modeling and Transportation Planning

Average Annual Support	ARC (2008)	ARC -2023	MORPC -2008	MORPC (2023)	NCTCOG -2008	NCTCOG -2023	PSRC -2008	PSRC (2023)	NYMTC (2023)
Number of Staff									
Model Applications	4	4	2						4 (includes 1 onsite contractor)
Model Maintenance and Development	3	3	2	4	7	7			3 (includes 2 onsite contractors)
Transportation Planning	17	17	5+		10	25		4	8
Data Collection and Maintenance	2	2	4*	4	2	6		8	4 (includes one on site contractor)
Land Use Modeling	2	2			2	3		3	3
Other								5	
Total Staff	28	28	12+		19	41	20	20	12 modeling, 47 total staff
Budget									
Travel Demand Modelling	$1,040,000	$1,040,000	$400,000	$400,000	$1,200,000	$1,500,000	$2,200,000	$70,000	$1,639,000
Transportation Planning	$2,920,000	$2,920,000	$600,000	$1,100,000	N/A	N/A			$4,737,000
Data Collection and Maintenance	$450,000	$450,000	$500,000	$500,000	$1,000,000	$1,500,000	$700,000	$720,000	$1,418,000
Land Use Modeling	$380,000	$380,000				$500,000			$198,000
Consultant Assistance	$500,000	$500,000					$250,000		$4,811,000
Other	$310,000	$310,000	$500,000		$1,750,000	$500,000	$300,000	$50,000	$3,193,000
Total Budget	$5,600,000	$5,600,000	$2,000,000	$2,000,000	$3,950,000	$4,000,000	$3,450,000 [10]	$840,000	$15,996,000

Tools and Educational Resources

The interviewed MPOs employ a variety of tools and educational resources to build their staff's capacity.

- PSRC uses DataCamp to build their staff capability including scripting and software engineering skills. DataCamp is an online learning platform for developing data science skills.
- As part of NYMTC's scope of work for the NYBPM 2012 and 2019 model updates, the staff and member agencies completed three days of hands-on training.
- NCTCOG noted that best practice examples such as detailed calibration reports and all project analysis can assist in defining the path for improvement based on successful

[10] The high number for annual support in 2008 represents a one-time contract to implement Daysim and move from a trip-based model to an activity-based model.

experiences. National Cooperative Highway Research Program synthesis, standardization, and transferability reports are very useful.

- Cooperative projects were noted by multiple agencies as a pathway for model improvements based on common needs such as development of regional DTA on a schedule-based transit assignment. FHWA travel forecasting resources, such as the Travel Model Improvement Program (TMIP), are also cited by multiple agencies as being useful.

Resource Sharing and Capacity Building

The interviewed MPOs leveraged working groups and peer reviews to build capacity and share knowledge among stakeholders and professionals in the industry. For instance, while NCTCOG did not have a formal working group, it participated in many internal peer reviews between the model team and the model users' team, often including transit agencies. The agency's application team had project-specific travel forecasting demand meetings during corridor and feasibility studies that include State DOTs and stakeholders within the project area. At PSRC, there was a regional model user group consisting of MPOs that meet periodically to exchange what they are working on and share best practices and lessons learned. MORPC leveraged the Ohio modeler user group quarterly meetings for coordination efforts. NYMTC staff participates in a statewide modeling working group and a forecasting working group, and has recently initiated a travel survey community of practice among member and neighboring agencies to better harmonize the regional survey and data program.

Partners and Collaboration

Collaboration with Other Entities

The interviewed MPOs collaborate with other entities in the realm of travel demand modeling as follows:

- Some MPOs collaborate with transit agencies by conducting transit surveys and providing travel demand modeling. For example, MORPC provided model outputs to the Central Ohio Transportation Authority (COTA) to support the development of COTA's long-range plan. NCTCOG also provided modeling and conducts transit surveys for the transit agencies in the region.
- Some MPOs collaborate with local universities through small grants on topics related to data and travel demand modeling. NYMTC is working with the State University of New York at Albany to develop their next travel survey and Cornell University to develop their air quality and congestion management process tools.
- Some MPOs collaborate with peers through the TMIP and the Transportation Research Board (TRB) annual meeting. One example of peer collaboration was 12 MPOs, including ARC, working together to create one unified model platform for ActivitySim. There are also state modeler user groups that enable coordination.
- Local governments adopt versions of the MPO's travel demand model for their areas. In ARC's case, local jurisdictions added more detailed networks and zone structures to the

model for local analysis. The model was calibrated by the local jurisdiction and validated to the local conditions.

- All of the interviewed MPOs collaborated with their respective State DOTs. This collaboration included regular meetings and/or coordination on federal initiatives, data purchases, reviewing deliverables, and travel surveys. Washington State DOT used the PSRC's travel demand model as an input for microsimulation. The New York State DOT participated in a model advisory committee to review the major deliverables, including output. Some of the State DOTs, like Texas DOT, Ohio DOT (ODOT), and GDOT, are often interested in project-specific modeling and gauging the impact of capital improvements.

3.5 Emerging Issues

As transportation planning faces new challenges and opportunities, MPOs are placing more demands on their travel demand models. Unforeseen emerging issues range from challenges, such as the COVID-19 pandemic, and opportunities, such as micromobility, all of which impact our transportation systems. Travel demand models are expected to analyze these issues. This section explores issues that have emerged since the 2008 report, and the MPO responses to them.

The 2008 report identified five emerging issues that the four-step travel demand models cannot address. These include:

- Time chosen for travel;
- Travel behavior;
- Non-motorized travel;
- Time-specific travel volumes and speeds; and
- Freight and commercial vehicle movements.

According to *TRB Special Report 288, Metropolitan Travel Forecasting: Current Practice and Future Direction (2007)*[11], an activity-based model can substantially address three of these emerging issues: time chosen for travel, travel behavior, and non-motorized travel behavior.

The MPOs provided information on their progress towards incorporating these emerging issues. ARC has included freight movement in their model and assigns truck trip tables for different types of trips to better account for travel and commerce. However, ARC did not have an e-commerce segmentation in the model but are properly accounting for truck VMT and using Highway Performance Monitoring System (HPMS) VMT adjustment factors.

E-commerce, Transportation Network Companies (TNCs), and micromobility are 2023 additions to the emerging issues noted in the 2008 and 2011 reports. The bolded answers reflect the change of responses from 2011. While ARC and NYMTC have since incorporated TNCs, only NYMTC surveyed incorporated emerging technologies such as micromobility or e-commerce into

[11] Special Report 288, Metropolitan Travel Forecasting: Current Practice and Future Direction, Transportation Research Board, 2007

their mode. The NYMTC 2019 NYBPM added the feature of an open road tolling option to their model. Table 6 presents the updated information to the 2008 and 2011 reports.

Table 6: Travel Demand Model Capacity to Address Emerging Issues[12,13]

Emerging Issue/Examples	ARC	MORPC	NCTCOG	NYMTC	PSRC
Road Pricing	**Yes**	Partially	Partially	Yes	Yes
Time dependent changes in speed and volume	Yes	No response	Partially	Yes	Yes
Peak spreading and highly congested networks	Yes	No response	Partially	Yes	Yes
Improvements in traffic operations	No response	No response	Partially	Yes	Partially
Dynamic conditions	No response	No response	No	No response	Yes
Goods movement/freight /freight policies	**Yes**	Partially	Partially	Yes	Yes
E-commerce*	Partially	No	No	Nor	No
Transportation Network Companies (TNCs)*	No response	No	No	Yes	Yes
Micromobility*	No response	No	Partially	Yes	No
Land Use Scenarios	Yes	Yes	Yes	Yes	Yes
Uncertainty in scenarios, parameters, model structures	Partially	Partially	Yes	No response	Partially

Managing Uncertainty

Travel demand forecast by its nature has some level of uncertainty. All the interviewed MPO staff acknowledge the uncertainties associated with travel demand forecasts. They also noted the challenge of integrating the uncertainties into their transportation planning process and communicating the uncertainties to the stakeholders and decision-makers. The interviewed MPO staff were researching uncertainty and developing ways to address this challenge at the time of the 2023 interview.

ARC strove to be mindful of risk and uncertainty but stated that accounting for uncertainties is a side exercise. It noted that the agency must be aware of the sources, including uncertainties introduced through data collection from survey design and stratification. ARC modeling staff communicated the model's uncertainties to their board and advocate that quantifying the

[12] Responses that are different from those given in the 2008 report are in **bold**.

[13] * indicates a new category of emerging issue/example included for the 2023 report.

uncertainty is an activity that the research community should be in charge of rather than the MPOs.

PSRC, NCTCOG, and NYMTC addressed uncertainty through scenario analysis or testing multiple scenarios such as telecommuting or zero-fare transit. At NCTCOG, uncertainties are also tested through parametric testing, where border values are determined as the applicability of the model is examined before the model run is set up. Other quantitative tools are specialized model runs or even a modified model version. NCTCOG stated that complex models only help when they reduce the uncertainties, which is generally achieved by established theories or availability of data for verification. Hypothetical assumptions for model development can make the situation even more complex.

Scenario Analysis

In addition to address uncertainties via scenario analysis as noted before, some of the interviewed MPOs are considering how to incorporate scenario analysis as a tool for addressing uncertainty. ARC was one of the participating agencies for the FHWA Strategic High Research Program (SHRP) Implementation Assistance Program Round 5[14]. The program is designed to guide both the technical and stakeholder aspects of scenario development. At ARC, exploratory scenarios were used in stakeholder conversations. ARC also plans to experiment with VisionEval and TMIP-Exploratory Modeling and Analysis Tool[15, 16] for their next LRTP update. ARC noted that the analyst role is very important to formulate the question so that the model development team can create a reasonable customized analysis tool. As part of their scenario planning work, ARC contracted with a consultant to develop an interactive tool[17] to educate participants on disruptive technologies and drivers of change. One region in Georgia used the ARC model to model different road pricing scenarios because of the uncertainty with gas tax revenue.

MORPC noted that their region is growing, and there is less emphasis in the region on transportation demand management and more on accommodating new capacity projects. MORPC performs build- and no-build scenarios based on project needs, like corridor studies or bus rapid transit (BRT). NYMTC uses sensitivity analyses and develops future forecast scenarios with altered key parameters to better understand changes in travel patterns, transit ridership, goods movement, and VMT.

With UrbanSim, PSRC considered uncertainty probabilities within the results by using the base years and future years. PSRC reported that they have integrated exploratory scenarios into the transportation planning process. PSRC has found it challenging to incorporate additional factors in scenario analysis as the model takes a long time to run. NCTCOG noted that their forecasting process will probably change from point estimate to a range of scenario analyses in the future.

COVID-19

[14] SHRP2 Element CO8 (Volume 2) Scenario Development Process, ARC
[15] TMIP EMAT Documentation, TMIP, FHWA
[16] Uncertainty in Travel Forecasting: Exploratory Modeling and Analysis TMIP-EMAT: A Desk Reference, FHWA
[17] Winning the Future, Sharpening Our Focus, ARC

COVID-19 has brought several new challenges to travel demand modeling and forecasting, especially the uncertainties associated with travel behavior changes. Most of the interviewed MPOs have now incorporated telecommuting into their travel demand models. However, there is not yet a straightforward approach. As ARC noted, coding essential workers, or those who cannot telecommute, can be challenging because essential workers span industries from retail to medical. NYMTC adjusted the SED forecasts to account for the impacts of the pandemic.

Baselining Post-COVID

Another challenge that arose from COVID-19 is finding a reference point year as a baseline. ARC's transit on-board survey was considered the last pre-pandemic survey in the United States. PSRC used 2018 and now is moving to 2023. ARC is currently using a baseline model calibration, called "2020X", which is a hybrid approach. ARC will use post-pandemic data, based on 2024 travel survey, to determine what has been the long-term impact of the pandemic on travel behavior. ARC was planning a mid-decade validation in 2025. At NYMTC, the latest socioeconomic and demographic dataset incorporated a lag in employment from 2020 to 2025 to account for the pandemic. MORPC's current model validation was using 2021 data, as Q2 2021 was the most recent available employment data.

Lingering Effects of COVID-19

Other impacts from the pandemic remain to be seen. NCTCOG acknowledged that the pandemic changes have not materialized yet, and it is obvious that, for the models calibrated before pandemic, some changes are inevitable such as transit models. The only part of the NCTCOG model that was clearly affected by COVID-19 is the transit system and ridership. NCTCOG has created options to deal with this change, but the official forecast cannot be changed because it has already been published. MORPC is aware of the limitations of their model and point forecast.

Induced Demand

While all of the models will reroute a fixed motor vehicle travel demand from congested routes to less congested routes, induced demand in response to land use changes is not considered uniformly across the travel demand models. ARC considered it to some degree, as the MPO used a fully integrated land use transport model that includes some induced demand.

PSRC considered induced travel demand throughout their modeling framework. The agency noted that it would be helpful if there are studies to compare model results to California's elasticity-based VMT calculator[18].

NYMTC did not consider induced demand an issue because the region is already heavily congested and not focused on building additional capacity.

Big Data

Technological advances continue to enhance and challenge transportation planning and travel demand modeling. Big data, or data generated by digital technologies such as mobile phones, websites, satellites, or sensors, can enhance an MPO's ability to understand travel patterns.

[18] California Induced Travel Calculator, National Center for Sustainable Transportation

Big data is used to a varying degree by the interviewed MPOs. ARC touted benefits, such as big data's capability to have better baseline traffic conditions for speeds and its ability to help predict potential changes in future travel. NCTCOG examined use of trip table data to enhance or replace trip generation and trip distribution. However, there is also concern that the reliability of this data is hard to gauge as noted by MORPC and NCTCOG.

Strategies for Obtaining Data

Big data subscriptions can be expensive, and four out of the five interviewed MPOs (NCTCOG, ARC, MORPC, and PSRC) did not have budgets for big data and had developed creative solutions for obtaining data. NYMTC, ARC, MORPC, and PSRC all used INRIX data. Instead of an ongoing subscription, PSRC used it as a one-time purchase for a specific plan. ARC canceled their subscriptions due to cost and was planning to use the FHWA NextGen National Household Travel Survey in the future. ARC was a member of the Eastern Transportation Coalition (formerly known as the I-95 coalition), which gave the MPO access to additional data. MORPC leveraged the ODOT's subscription for a big data source. At NCTCOG, travel survey and data purchases depended on cooperation with other agencies and project sponsors; the stability and reliability of the passive data is not mature enough to be in a long-term program in a predictable way. Before the agency made data purchases, NCTCOG examined the landscape of available data or survey processes and made decisions accordingly.

Emerging Technology

MPOs are at various stages in incorporating emerging technologies such as AV, EV, TNC, E-Commerce, and mircomobility. Most MPOs are considering AVs to some extent, whether it be exploratory scenarios or through model derivatives. NCTCOG, ARC, and MORPC indicated that they have made progress to model the effects of AVs in the 2023 interview. MORPC noted that one challenge to modeling AVs is that there is no data with which to calibrate the model. NYMTC used EV adoption rates and their impact on the air quality analysis in the post-processing of the travel demand model results.

Climate Change and Resiliency

The 2011 addendum indicated that most of the MPOs interviewed for that report had only begun to consider the newer policy issues of sustainability, climate change, and livability. At the time, PSRC had some tools to examine climate change, and ARC had included additional post-processing into their air quality analysis to address climate change, primarily in its consideration of greenhouse gases. In 2011, the models did not directly address sustainability or livability concerns. Regarding sustainability and livability specifically, it appears that there is no change – the interviewed MPOs either conduct non-travel demand modeling analysis or post-processing. None of the interviewed MPOs models resiliency using their existing travel demand models. One promising application is using the regional travel demand model for an assessment of rainfall scenarios and runoff management, as was reported by NCTCOG. NYMTC's model has been used to plan evacuation routes.

PSRC outlined regional climate goals in their RTP. To help meet regional climate goals, they have various strategies of discouraging motor vehicle travel (e.g., pricing, roadway removal, transit expansion).

PSRC has been using the model to determine which policy and planning actions could help the region to meet its climate goals as part of their long-range transportation planning process. For example, the model results showed that implementing a road user charge of 0.25 per mile, a 20 percent work-from-home rate, and an increase in EV ownership have the capacity to achieve the 2030 climate goal of carbon dioxide emissions reduction to 50 percent below 1990 levels (the result is not in published documents such as their current official LRTP at the time of 2023 interview).

Equity

All of the interviewed MPOs use the model for equity and/or environmental justice analyses in some fashion, but this analysis is normally completed off-model, through post processing of model results. None of the TDMs of the interviewed MPOs were directly employed to address these issues at the time of the 2023 interview. For example, ARC noted that equity analysis is done off-model, post-processing with the output from ARC activity-based model. One NYMTC member used forecasted changes in truck traffic to implement mitigation efforts aimed at addressing equity along an interstate corridor.

Some of the interviewed MPOs, like NYMTC, ARC, and PSRC, used census information (e.g., sociodemographic data such as income, race) to determine equity geographics and assess planning impacts to those areas in base and future years. In the case of PSRC, using the model for equity analyses is becoming an increasingly frequent practice[19]. PSRC utilized the post-processing of model results to evaluate equity for the region. PSRC has begun to experiment with constructing synthetic populations with person's race and ethnicity as a controlled variable. Then the person's race and ethnicity can be used in model metrics, for example, to measure transit mode share by race, or emissions exposure by race and ethnicity.

[19] Equity, Puget Sound Regional Council

4.0 Conclusion

Since the 2011 update of the "Snapshot of MPO Travel Modeling Activities," the TDM outputs continue to contribute to the process of selecting the final projects, even though the model outputs are not directly employed in agencies' project prioritization. The expectations for the regional travel demand models continue to increase. Most of the five MPOs interviewed have been working on improving their models' capabilities. They have been experimenting on the possibilities of utilizing their existing travel demand models for some of the emerging analysis needs and evolving planning priorities. ARC, PSRC and NCTCOG have been exploring the potentials of using scenario analysis to address issues such as increased number of remote workers, EVs and AVs, e-commerce, on-demand transportation services, and high-speed rail. NCTCOG indicated their current model can partially address telecommuting, and MORPC noted that their model "can incorporate AVs and telecommuting."

Quality data and cost of acquiring data continue to be a challenge for the interviewed MPOs. While emerging data such as locational based data are more accessible, the cost and uncertainties associated with the quality remain to be a concern for the agencies interviewed. All the MPOs acknowledge the limitations and uncertainties associated with current TDMs. As NYMTC noted, some of the limitations are limitations in data used for model development, simplifications, and aggregation errors.

The interviewed agencies are mindful of uncertainties associated with travel demand models and their demand forecasts. They tried to navigate through these uncertainties in their own way; however, at the time of this report update, they do not have a formal process to address or manage those uncertainties. The agencies tried to address uncertainties in data or future exogenous conditions through qualitative or quantitative scenario analysis. NYMTC spoke about the development of alternate future scenarios to manage uncertainty. NCTCOG reported that generally uncertainties are tested by scenario and parametric testing, and if the models can handle the answer too, the border values are determined before the model run is set up.

All the agencies interviewed collaborate with their State DOTs and try to take advantage of available educational resources building their professional capacity. All of the interviewed MPOs have a suite of tools assisting analyses of emerging issues. They report that their existing travel demand models (and land use modeling vehicles) are generally sufficient for their agency's existing needs such as providing travel demand forecasting for their long-range transportation plans and transportation conformity analyses.

Motivation for major model update varies. NCTCOG updates their model for accuracy in the short term and due to policy, new technology, and travel behavior changes in the long term. MORPC updates their model with the long-range plan update cycle and when moving modeling platforms or in response to ODOT changes. PSRC reported climate change and pricing motivate most of PSRC's model improvements both in the 2008 and 2023 interviews. NYMTC indicated that, for their model updates over both the long and short term, fulfilling the transportation conformity determination requirement is the main motivation as well as the related need to ensure that the time between the model's base year and the current year does not exceed 10 years. ARC also cited conformity determination as the motivation for model updates in both the short and long term in 2008 and 2023 interviews.

Even though there are common challenges, smaller MPOs such as MORPC have their unique challenges. Each of the MPOs interviewed develops its model and maintains a suite of tools based on the need of the region. None of the MPOs interviewed was considering a new travel forecasting technique at the time of the 2023 update.

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