

# **Use of Travel Demand Models in the Evaluation of MAP-21 Performance Measures: A Survey of MPO Practices**

Stephanie Ivey<sup>1</sup>, PhD and Daniel Badoe<sup>2</sup>, PhD

<sup>1</sup>University of Memphis

<sup>2</sup>Tennessee Technological University

# Presentation Outline

- Introduction
  - Performance Measure Requirements of MAP-21; and
  - Study Objectives
- Methodology
- Literature Review and Agency Website Findings
- Results of Nationwide Survey of MPOs
- Conclusions
- Next Steps

# Introduction

- MAP-21 requires:
  - MPOs to establish and use a performance-based approach to transportation decision-making and development of long range transportation plans (LRTP)
  - MPOs to set performance target for each performance measure
  - MPOs to show how Transportation Improvement Program (TIP) will lead to achieving the performance targets established in the plan

# Introduction

- Performance measures to be set by the Secretary, in consultation with States, MPOs, and other stakeholders
- Areas of the performance measures are:
  - Pavement condition on the Interstate System and on remainder of the National Highway System (NHS)
  - Performance of the Interstate System and the remainder of the NHS
  - Bridge condition on the NHS
  - Fatalities and serious injuries—both number and rate per vehicle mile traveled--on all public roads
  - Traffic congestion
  - On-road mobile source emissions
  - Freight movement on the Interstate System

# Introduction

- DOT to establish such performance measures within 18 months of enactment
- DOT prohibited from establishing additional performance measures

# Introduction

- Study Objective
  - Investigate how MPOs nationwide use or are planning to use regional travel demand models to aid in addressing the pertinent performance measure requirements of MAP-21

# Methodology

- Conduct a review of the relevant literature
  - Used to identify current approaches for using travel demand model outputs in performance measure assessment
- Conduct a nationwide survey of MPOs
  - Undertaken to identify existing or planned use of travel demand models for addressing MAP-21 requirements

# Literature Review Findings

- Sacramento:
  - Sacramento Area Council of Governments (SACOG) uses travel demand model to estimate congested vehicle miles traveled (VMT), defined as VMT occurring on network links where the volume to capacity ratio ( $v/c$ ) is greater than one
  - SACOG finds this measure to be more representative of what travelers actually experience than network delay



# Literature Review Findings

- Mid-Ohio Regional Planning Commission (MORPC)
  - MORPC has 25 performance measures with 13 targets established to address its system objectives
  - MORPC is revisiting these metrics to create alignment with MAP-21
  - Currently uses congested vehicle miles traveled and, thus, already addresses the congestion performance category established by MAP-21

# Literature Review Findings

- Savannah Metropolitan Planning Commission (SMPC)
  - Already have performance measures that address congestion, reliability, and mobile emissions, which will serve MAP-21 requirements
  - SMPC uses their travel demand model for VMT, v/c, and level of service (LOS) comparisons between base year and projected year or scenario simulations to address these performance measure categories

# Literature Review Findings

- Survey of MPOs by Citilabs (Brown and Lee, 2013):
  - 100 MPOs responded
  - 62% already use performance measures in their current LRTP
  - MPOs that use conventional four-step models were more likely than those using three step, activity, or tour-based models to include performance measures
  - Agencies incorporating performance measures were also more likely to use modeling scenarios to assess alternatives.
  - Agencies were most likely to use travel models to forecast mobility or environmental category performance measures

# Literature Review Findings

- **Georgia DOT** will evaluate congestion performance measures using the statewide and MPO travel demand models
- **Southern California Association of Governments (SCAG)** plans to use
  - Travel demand model derived network travel time and measures of delay (annual vehicle hours and person hours of delay) to address the congestion performance measure and
  - Travel time reliability and person throughput per lane to monitor the national highway system performance measure

# Literature Review Findings

- **Regional Transportation Commission (RTC) of Washoe County, Nevada**
  - Plans to use their travel demand model for evaluating proposed projects' alignment to agency goals by comparing baseline and future scenarios for performance measure targets
- **Washington State Department of Transportation**
  - Demonstrated that travel demand models have an ability to compute changes in network travel times, (i.e., an improvement over many sketch planning tools that only estimate link-level travel time changes), which can be useful for performance measure metrics

# Literature Review Findings

- **ICF International**

- Identified 12 performance measures that have the potential for assessment through travel demand models.
- These include:
  - Transit accessibility
  - bicycle and pedestrian mode share
  - vehicle miles traveled per capita
  - bicycle and pedestrian activity and safety
  - bicycle and pedestrian level of service
  - average vehicle occupancy, and
  - transit productivity

# Literature Review Findings

- **Metropolitan Washington Council of Governments** (Pu and Meese, 2013)
  - Study to determine how useful new data sources may be for meeting MAP-21 performance measure requirements
    - Found that probe-based data can significantly enhance congestion and reliability monitoring efforts
    - Cited data management issues that can complicate use of probe-based data (non-standard forms, varying processing methodologies)
    - Encountered difficulty in
      - describing measures of system reliability in a way that the general public could readily understand, and
      - determined that there is no single measure that can fully assess both congestion and system reliability



# Findings of Review of Agency Websites

- 290 MPO websites and LRTPs reviewed
- Each LRTP examined to determine
  - Whether or not performance measures were explicitly addressed in the current plan,
  - To identify the performance measure categories where travel model outputs were used (if possible), and
  - To identify the specific model outputs used in performance measure evaluation



# Findings of Review of Agency Websites

Performance Measure Category	Number of Agencies Using Travel Model for Performance Measure Assessment			
	MPO Population Served			
	50,000- <200,000	200,000- <500,000	500,000- <1,000,000	>1,000,000
Pavement Conditions	6	11	3	4
Reliability, Efficiency, and Access	30	29	19	19
Bridge Conditions	11	8	5	5
Fatalities and Serious Injuries	27	19	14	13
Congestion	36	32	21	24
Mobile Source Emissions	16	14	8	14
Freight Movement	8	11	7	5

# National Survey Methodology

- Questionnaire consisting of fourteen questions developed in SurveyMonkey.com on January 3, 2014
- Questions addressed:
  - MPO size
  - Model type
  - Modes considered within the model
  - Use of models to address performance measure requirements
  - Consideration of multiple scenarios
- Invitation to participate in survey sent to the 384 MPOs in the database.
- Reminder message sent to non responding MPOs:
  - Three weeks after first contact; and if still no response
  - Six weeks after first contact

# Results of National Survey

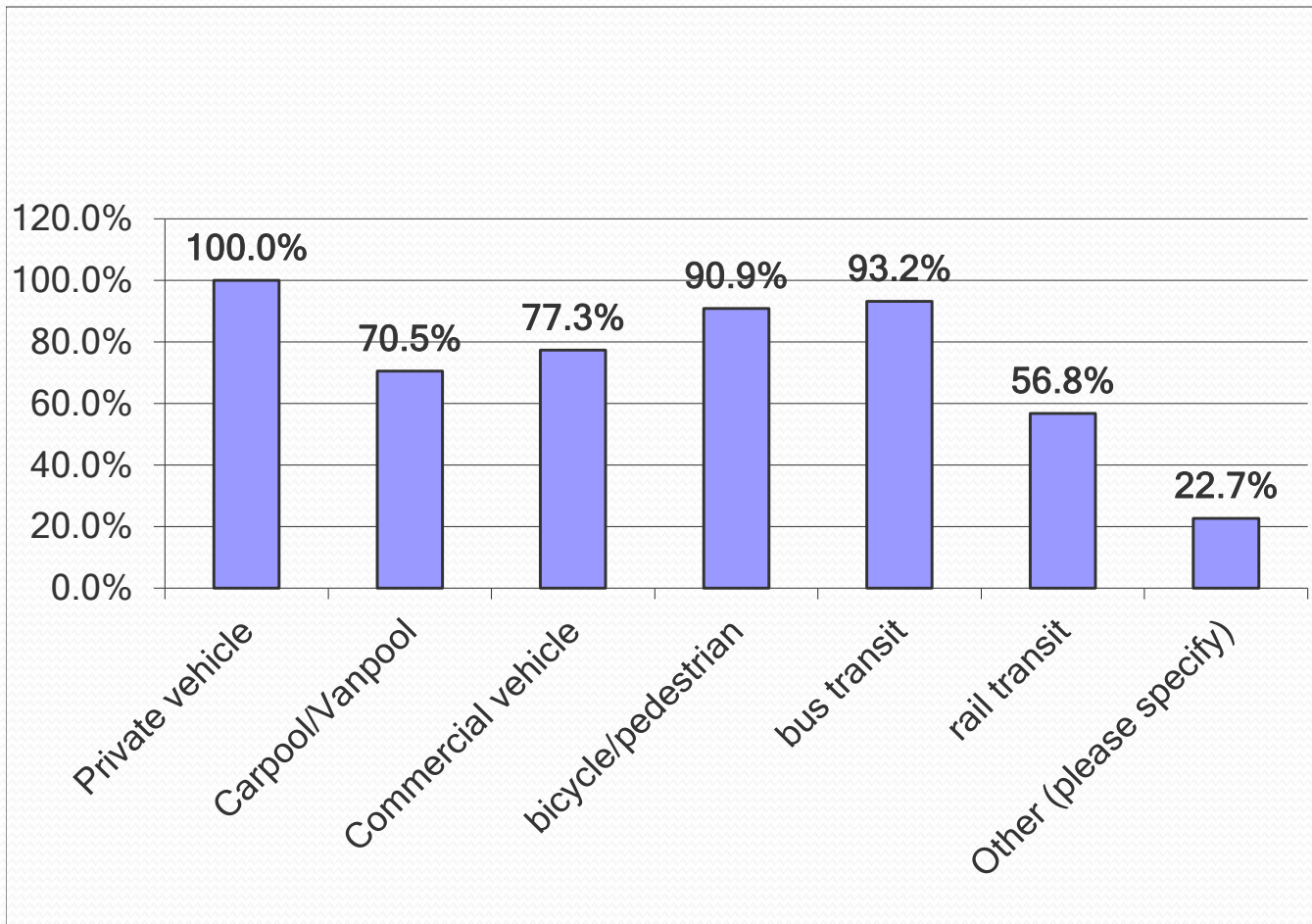
- Number of MPOs that completed the survey is 44
  - Thus survey response rate is about 11.5%
  - Responding MPOs located in 23 states that have representation in each of the major geographic regions of the US

**Table 1: Distribution of Responding MPOs by Regional Population**

Population of MPO Region	Response Percent	Response Count
50,000 – <200,000	45.5%	20
200,000 - <500,000	13.6%	6
500,000 - <1,000,000	11.4%	5
>1,000,000	29.5%	13

# Results of National Survey

## Modes considered in Long Range Transportation Plan



**Figure 2:** Chart of Modes Considered in Long Range Transportation Plans

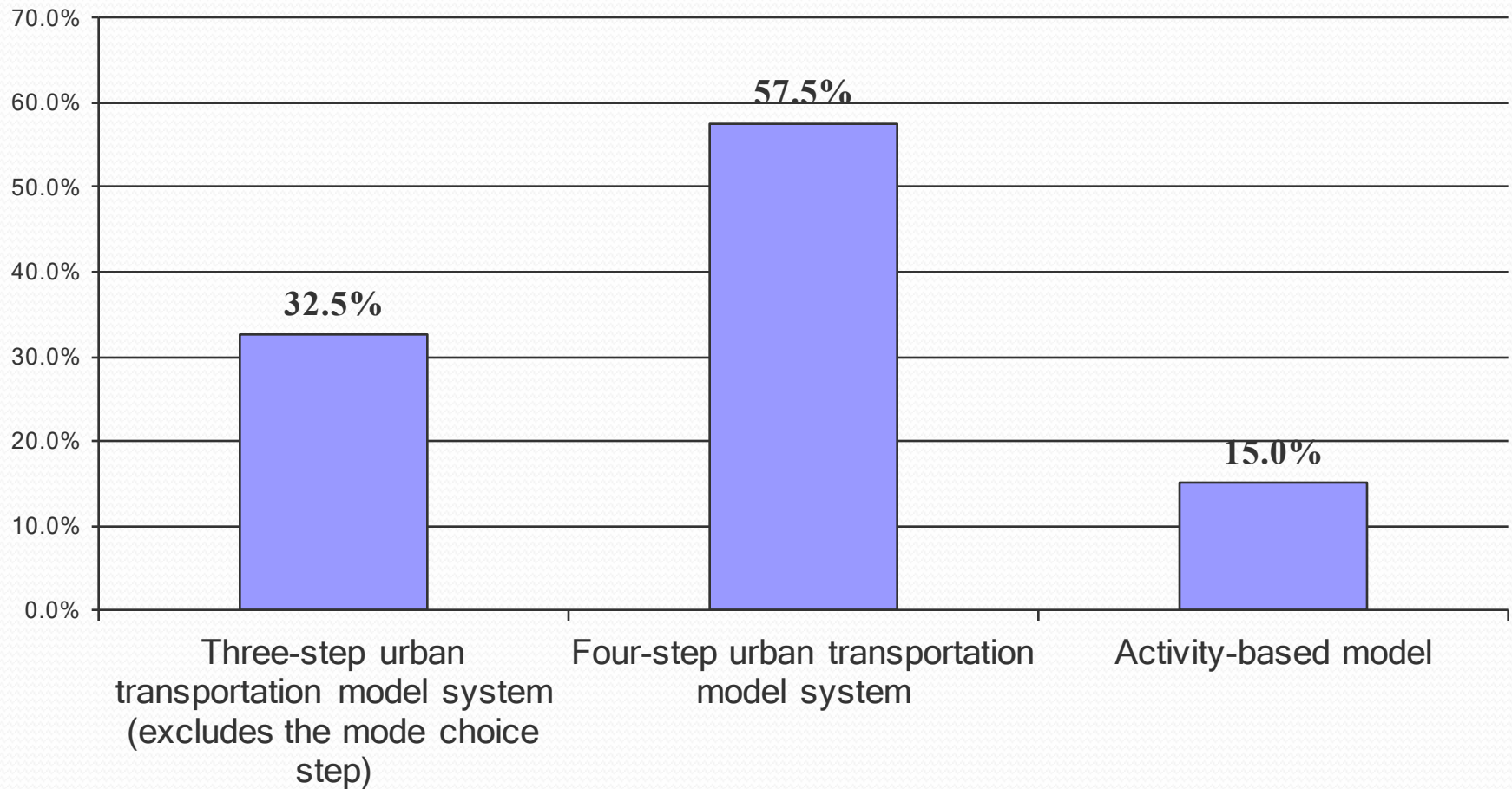
# Results of National Survey

## Modes Considered in LRTP by MPO Size

- For “**very large**” MPOs (service area population > 1,000,000)
  - More than 80% of them included all the listed modes
  - 100% included private vehicle, carpool/vanpool, and bus transit
  - 92% included commercial vehicle and non-motorized modes, and
  - 85% included rail transit within their models
- For “**midsize to large**” MPOs (200,000 - < 1,000,000)
  - 72% included all the listed modes
  - 100% included private vehicle, non-motorized, and bus transit modes
  - 81% included carpool/vanpool; and
  - 72% included commercial vehicles and rail modes
- For “**Small**” MPOs (50,000-<200,000)
  - 100% included the private vehicle mode
  - 85% included bus transit and non-motorized modes
  - 70% included commercial vehicles
  - 45% included carpool/vanpool
  - 30% included rail transit

# Results of National Survey

## Type of Travel Demand Model used in LRTP



# Results of National Survey

## Type of Travel Demand Model used in LRTP by MPO Size

- For MPOs in the “**very large**” category
  - 77% use four-step UTMS
  - 38% use activity-based models - some MPOs reported using both types
- For “**midsize to large**” MPOs
  - 80% use four-step UTMS
  - 10% use a three-step UTMS
  - 10% use an activity based model.
- For “**Small**” MPOs
  - 70% use a three-step UTMS
  - 30% use a four-step UTMS

# Results of National Survey

## **Developing Estimates of Non-motorized Demand**

- 30% do not estimate demand for non-motorized modes
- 9% could not provide any details because modeling is not done in-house
- 25% use multinomial logit or nested-logit model
- 25% use a pre-distribution mode split model (either direct generation or trip end mode split)
- 5% estimate through discussion with professional planners



# Results of National Survey

## **Developing Estimates of Public Transit Demand**

- 20% do not estimate transit demand
- 7% could not provide details because modeling is not done in-house
- 41% use multinomial logit or nested-logit model
- 14% use pre-distribution mode split model

# Results of National Survey

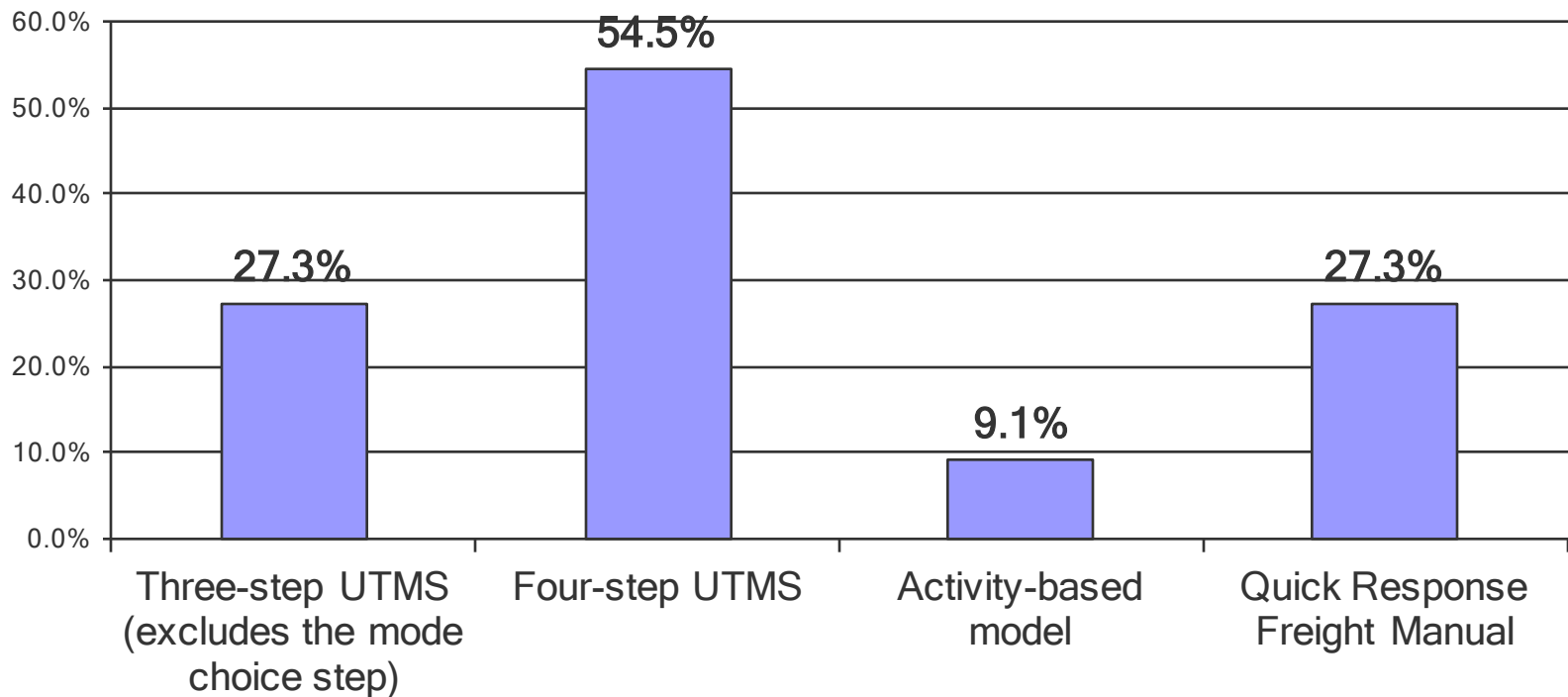
## Use of Freight/Truck Model

Freight/ truck model for forecasting?	Response Percent	Response Count
No	72.7%	32
Yes	27.3%	12

Type of model	Response Percent	Response Count
A truck model	75.0%	9
A freight model (multimodal)	25.0%	3

# Results of National Survey

## Use of Freight/Truck Model



# Results of National Survey

**Performance Measure Categories Addressed/to be Addressed Through TDM**

Performance measure categories	Response Percent	Response Count
Pavement condition on the Interstate System and on remainder of the National Highway System (NHS)	28.2%	11
Performance (reliability, efficiency, access) of the Interstate System and the remainder of the NHS	59.0%	23
Bridge condition on the NHS	17.9%	7
Fatalities and serious injuries—both number and rate per vehicle mile traveled--on all public roads	41.0%	16
Traffic congestion	97.4%	38
On-road mobile source emissions	61.5%	24
Freight movement on the Interstate System	30.8%	12

# Results of National Survey

## Performance Measure Categories Addressed/to be Addressed Through TDM

Performance measure categories	Very Large MPOs	Midsize to Large MPOs	Small MPOs
Pavement condition on the Interstate System and on remainder of the National Highway System (NHS)	23%	20%	37%
Performance (reliability, efficiency, access) of the Interstate System and the remainder of the NHS	85%	40%	50%
Bridge condition on the NHS	23%	--	25%
Fatalities and serious injuries—both number and rate per vehicle mile traveled--on all public roads	46%	40%	37%
Traffic congestion	92%	100%	100%
On-road mobile source emissions	92%	70%	31%
Freight movement on the Interstate System	69%	10%	12%

# Results of National Survey

## How will Model Results be used?

- *Measure congestion via v/c ratios*
- *Validate performance reports to existing data and utilize to forecast traffic*
- *We will use our TDM for traffic congestion and mobile source emissions. We have other models (i.e., an Asset Management Model that predicts pavement conditions that may help to measure performance for some of these other categories. We also use the Highway Safety Manual, which can be used to predict the locations of fatalities and serious injuries.)*
- *Model future year socio-economic projections onto TIP network, LRTP fiscally constrained network, and Added Funding Network. Difference in performance measures between TIP and LRTP (build versus no-build, so to speak) will be used to show progress towards goals and targets through implementation of the LRTP.*

# Results of National Survey

## How will Model Results be used?

- *The model supports both our CMP and AQ modeling. Our CMP includes measures for system reliability, congestion duration, and travel times as measured by both a congestion index and the inverse measure, travel time index. We are learning more about the tools in the highway safety manual, and are working to understand and incorporate model results into the crash prediction tool. We are also working to incorporate the data provided by HERE through the FHWA agreement into our modeling efforts, and are specifically looking at the ATRI data contained in the HERE data set to assist us with understanding and forecasting freight movements.*
- *Tracking Congested Vehicle Miles Travel (Collecting speed data with traffic counts). Tracking Daily Vehicle Hours of Delay. Transit performance (Cost per mile, ridership increase/annual operating cost)*

# Results of National Survey

## How will Model Results be used?

- *We are still in the process of determining what tools we will use to set targets for the categories. The expectation is that we will use real-time data (e.g. INRIX data) to help with the congestion, reliability and freight measures. It's possible that the model will be used to help understand potential future outcomes to determine reasonable targets but that is still being analyzed.*
- *Our agency intends to use the travel demand model to evaluate alternative investment scenarios with regards to publicly established goals and targets. This will be used in the project selection phase of the regional transportation plan.*



# Results of National Survey

## How will Model Results be used?

- *Determining future travel delay on our highway network. Aiding in the AQ conformity process.*
- *Our model does not address pavement condition, bridge condition. We can address congestion and reliability.*
- *Whatever the model has direct outputs for (performance with regard to reliability, efficiency, access, congestion) will be used to address the performance measures.*
- *Evaluating strategy scenarios to achieve performance targets.*

# Results of National Survey

- Performance targets set?
  - No – 80%
  - Yes – 18%

Intend to use multiple scenarios	Response Percent	Response Count
Yes	70.5%	31
No	29.5%	13

# Conclusions

- Based on literature review, many MPOs and state DOTs already have performance measures incorporated into their transportation planning process. In some MPOs and DOTs, however, some realignment of performance categories will be required to conform to MAP-21 requirements
- Some MPOs and DOTs use or plan to use their travel demand models, where applicable, to forecast future performance of their transportation system.

# Conclusions

- Based on the national survey, the majority of responding MPOs (32 of the 44) do not use a truck/freight model in the development of their long-range transportation plans. Thus, these agencies will not be directly using truck/freight models for forecasting performance metrics defined in the pertinent National Goal Areas.
- The three national goal areas which stood out in terms of MPOs already using or planning to use demand models to evaluate associated performance measures were (1) Congestion Reduction ( $\approx 97\%$ ); (2) Environmental Sustainability ( $\approx 62\%$ ); and (3) System Reliability ( $\approx 59\%$ ).
- While 60% of the responding MPOs have plans to directly forecast some of the system performance measures or use a post traffic assignment processor on the demand model outputs to generate the forecasts, a significant fraction (30%) have yet to determine how performance measures will be forecasted.

# Conclusions

- Discrepancies exist based upon MPO size in terms of types of travel models in use, travel modes considered explicitly in models, and planned use of travel demand models in developing system performance measures.
- Results of the study point to the need to share experience with regard to performance measure development across MPOs, but particularly for small to mid-size MPOs that may not have staff time available to fully explore all of the opportunities for using travel models in depth.

# Next Steps

- Follow-up Interviews
  - More clarity regarding:
    - How TDM model output will be used for addressing performance measure categories (particularly for those agencies reporting unique applications)
    - Additional sources are being considered to aid in addressing performance measure categories
    - Methodologies for establishing performance measure targets
    - Context of multiple scenario analyses
    - Other suggestions?