NCHRP Project 8-36C, Task 137

Assessing the Utility and Costs of Statewide Travel Demand Models: Executive Summary

Requested by:

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Prepared by:

Gregory D. Erhardt
University of Kentucky

Flavia Tsang
RAND Corporation

Daniel Francis
University of Kentucky

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Executive Summary

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The goal of this research is to assess the expected cost and utility that can be expected to accrue from developing or upgrading a statewide travel demand model. Statewide travel models are computer simulations of the transportation system within a state that can be used to forecast the change in traffic conditions that would result from infrastructure or policy changes. Most states operate statewide models. Among those that do, there is a considerable range of model types and uses.

The core audience for this report will be technical or planning staff at state transportation agencies who must make a recommendation on whether and how to engage in statewide modeling at their agency. To make a recommendation, those individuals need to specify a budget request both in terms of external costs (consultants and materials) and in terms of staff time. They also need to be able to, at a minimum, articulate, and preferably quantify, the value they expect to achieve by pursuing the proposed approach.

This research quantifies the costs of statewide models, and both identifies and quantifies the benefits of statewide models in a range of situations. It does so using a novel approach that combines data on the revealed outcomes of existing statewide models, with the collective professional judgment of statewide modelers.

This report serves as a complement to the recently published NCHRP Synthesis 514: Statewide and Megaregional Travel Forecasting Models: Freight and Passenger (Donnelly & Moeckel, 2016). Note that this report is referred to in the appendices as NCHRP 20-05 Topic 47-17 based on its draft title. Readers are referred to NCHRP Synthesis 514 for a more detailed review of the methods and data currently used in practice, as well as new and emerging opportunities. Whereas NCHRP Synthesis 514 goes into the "How?" of statewide modeling, this research focuses on the questions of "Why?" and "How much?" That is, it considers the rationale for when it is or is not a smart decision to invest in developing or upgrading a statewide travel model.

The findings in this report are based on a series of structured interviews with statewide modelers and transportation planners. In total, representatives from 29 state Departments of Transportation (DOTs) and 5 consulting firms participated.

The interviews are structured around a series of 9 hypothetical scenarios, as summarized in Table 1. The scenarios span two dimensions: model development options and policy focus. The model development options recognize that developing a statewide model is not a binary choice, and that states that currently have a relatively simple model are still faced with the choice of whether it is worth upgrading that model. The policy focus dimension recognizes that the value derived from a model is likely to depend on the types of policies that the DOT is interested in. Together, they are intended to span a sufficient range of scenarios such that readers of this report can reasonably identify with one of them. This report is intended to help readers at state DOTs select a model development option based on the policy focus area most closely aligned with their DOT.

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Table 1 Interview Scenarios

		Model Development Options		
		M1	M2	M3
		Start from: No Model	*Start from:* Basic 3-step model	*Start from:* Enhanced 4-step model
Policy Focus		*Upgrade to:* Basic 3-step model with transferred model parameters, static truck trip tables.	*Upgrade to:* Enhanced 4-Step Model with estimated parameters, National Long-Distance Model, FAF-based commodity flows model, NHTS add-on sample.	*Upgrade to:* Activity-based model with estimated parameters, custom long-distance travel model, policy-sensitive freight model, custom travel surveys.
P1	Rural highways: Primary need is to evaluate highway projects outside urban areas.	Scenario P1-M1	Scenario P1-M2	Scenario P1-M3
P2	Congestion & multi-modal: Also a need to evaluate projects in urban areas, transit projects, truck projects and/or rail/intermodal projects.	Scenario P2-M1	Scenario P2-M2	Scenario P2-M3
P3	Policy, pricing & environment: A need to test broader policy or global scenarios, such as congestion pricing, demand management, growth scenarios, demographic changes, environment, equity and connected & autonomous vehicles.	Scenario P3-M1	Scenario P3-M2	Scenario P3-M3

The discussion below summarizes major findings from those interviews, with more detailed results available in the main report and associated appendices.

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1 Cost

The respondents were presented three model development options, and asked to estimated the cost of each. The included going from no model to a Basic 3-Step Model, upgrading from a Basic 3-Step Model to an Enhanced 4-Step Model, and upgrading from an Enhanced 4-Step Model to an Activity-Based Model. Chapter 5 presents the results of this cost estimating exercise, and

Table 2 summarizes the total cost of model development and data collection. The columns in Table 2 are for the different model development options, and the rows are segmented by the type of respondent: those from DOTs at small states, those from DOTs at large states, and those from consulting firms. Each cell presents the average estimate, as well as the lower quartile and upper quartile estimates.

The analysis revealed that a large portion of the cost of statewide modeling is associated with data collection. Each cell in Table 2 also shows the percent of the cost associated with data collection. This includes both household travel surveys, and base-year data such as commercial speed data and trip tables derived from mobile phone data. The scenarios were defined such that the development of a Basic 3-Step Model would not involve any data collection, and would instead rely on model parameters transferred from other states or national reports. The interviews revealed very different judgments about the level of data collection desired to support statewide modeling (as well as for other uses), with that level being an important driver of the cost.

While these costs can provide a starting point for budgeting, they represent a specific model scope. The interviews revealed a diversity of approaches currently used in practice, many of which draw elements from more than one of the modeling approaches presented here. Chapter 5 presents more detailed tabulations, while Appendix F provides a worksheet that can be used to develop a customized cost estimate by selecting the desired components from different model types.

It is also important to note that statewide modeling is not a one-time cost. There is a need to operate and maintain the models, and to keep the data they use current. The tables in Chapter 5 include estimates for these costs. Whereas most states rely on contractors to develop their models, all but one state interviewed relies on their own staff to fill these maintenance roles.

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Table 2 Summary of Estimated Model Development and Data Collection Costs

Average (Lower Quartile – Upper Quartile)

		Model Development Options		
		M1	M2	M3
		Start from: No Model	*Start from:* Basic 3-step model	*Start from:* Enhanced 4-step model
State Size		*Upgrade to:* Basic 3-step model with transferred model parameters, static truck trip tables.	*Upgrade to:* Enhanced 4-Step Model with estimated parameters, National Long-Distance Model, FAF-based commodity flows model, NHTS add-on sample.	*Upgrade to:* Activity-based model with estimated parameters, custom long-distance travel model, policy-sensitive freight model, custom travel surveys.
S1	Small State < 3.75 million population	$645,000 ($245,000-$1,031,000) Data Cost: N/A	$675,000 ($445,000-$868,000) Data Cost: 36%	$1,268,000 ($950,000-$1,394,000) Data Cost: 43%
S2	Large State >= 3.75 million population	$528,000 ($398,000-$650,000) Data Cost: N/A	$1,815,000 ($1,300,000-$2,125,000) Data Cost: 57%	$4,974,000 ($2,145,000-$7,944,000) Data Cost: 66%
S3	Consultant Estimate	$531,000 ($410,000-$500,000) Data Cost: N/A	$1,490,000 ($1,275,000-$1,800,000) Data Cost: 45%	$2,792,000 ($1,500,000-$4,170,000) Data Cost: 51%

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2 Utility

DOTs reported using statewide models for a range of applications, as discussed in Chapter 4. The most common were to generate highway forecasts outside of urban areas, to evaluate alternative growth scenarios, and to evaluate pricing scenarios. They also rated statewide models as more effective than non-model alternatives for analyzing some types of projects, with the effectiveness varying by the type of model.

States reported a variety of motivations for developing statewide models. Often, statewide models were developed to support a specific project or study, and then continued in use after the completion of that study. Specific applications that were identified by multiple respondents as important motivators for statewide models include: forecasting traffic for new facilities, bridge analysis, detour and emergency route analysis, providing external flows for urban models, feeding into economic analysis, and providing a consistent basis for project prioritization.

Respondents repeatedly gave the advice that it is important to match your model to your policy interests. They suggested that the advantage of more sophisticated models was the ability to analyze a broader range of policies, and that such models had little value if the agency is not interested in those capabilities. Even with an interest in such policies, there was disagreement over the value of activity-based models. Some states saw them as useful tools, while others did not think they were worth the added complexity.

In an effort to quantify the value of statewide models, and to see how different model types align with different policy interests, respondents were given a series of scenarios in which they were asked how much they would be willing to pay for each model upgrade, given a specific policy focus of their agency. The three possible policy foci are: Rural Highways, Congestion and Multimodal, and Policy, Pricing and Environment. Each is summarized in blue in Table 3, and each includes all of the applications considered in the policy focus before it.

Table 3 shows the results of this willingness to pay exercise. The values are the willingness to pay, reported as a 10-year cost per capita. For example, a state with 1 million population would be willing to pay $610,000 over 10 years ($0.61 x 1,000,000) to go from no model to a Basic 3-Step Model if their policy focus is rural highways. This would include the cost of developing the model, collecting data, and paying staff to operate and maintain it. The per capita framing recognizes that the same model serving a state with more people would have more utility. The values build upon each other. On average, a state with a rural highways policy focus would be willing to pay an additional $0.54 per capita to upgrade from a Basic 3-Step Model to an Enhanced 4-Step Model.

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Table 3 Willingness to Pay for Model Upgrades, in 10-Year Cost per Capita

Average (Lower Quartile – Upper Quartile)

		Model Development Options		
		M1	M2	M3
		Start from: No Model	*Start from:* Basic 3-step model	*Start from:* Enhanced 4-step model
Policy Focus		*Upgrade to:* Basic 3-step model with transferred model parameters, static truck trip tables.	*Upgrade to:* Enhanced 4-Step Model with estimated parameters, National Long-Distance Model, FAF-based commodity flows model, NHTS add-on sample.	*Upgrade to:* Activity-based model with estimated parameters, custom long-distance travel model, policy-sensitive freight model, custom travel surveys.
P1	Rural highways: Primary need is to evaluate highway projects outside urban areas.	$0.61 ($0.28-$0.69)	$0.54 ($0.09-$0.78)	$0.28 ($0.00-$0.37)
P2	Congestion & multi-modal: Also a need to evaluate projects in urban areas, transit projects, truck projects and/or rail/intermodal projects.	$0.78 ($0.28-$0.85)	$0.78 ($0.30-$0.88)	$0.71 ($0.30-$1.00)
P3	Policy, pricing & environment: A need to test broader policy or global scenarios, such as congestion pricing, demand management, growth scenarios, demographic changes, environment, equity and connected & autonomous vehicles.	$0.83 ($0.25-$1.00)	$0.87 ($0.33-$1.13)	$0.88 ($0.40-$1.08)

7.3 Cost versus Utility

A corollary question is how the costs relate to the utility. Table 4 shows one way of viewing this relationship. The first two rows show the average reported 10-year spending per capita on statewide modeling. This is what states reported they actually spent, not what they estimated for the above scenarios. The bottom three rows show the willingness to pay, taken from Table 4. The fact that the willingness to pay values are higher than the reported spending suggests that states are perceived to be getting good value for their investment in statewide modeling.

Table 4 Total per-capita Spending vs Utility of Statewide Model over 10 Years

	Category	Basic 3-Step Model	Enhanced 4-Step Model	Activity-Based Model
Average 10-Year Spending per Capita	Population < 3,750,000	$0.25	$0.15	$0.42
	Population >= 3,750,000		$0.22	$0.39
Average 10-Year Willingness-to-Pay per Capita*	Rural Highways Focus	$0.61	$0.54 ($1.15)	$0.28 ($1.43)
	Congestion & Multi-Modal Focus	$0.78	$0.78 ($1.56)	$0.71 ($2.27)
	Policy, Pricing & Environment Focus	$0.83	$0.87 ($1.70)	$0.88 ($2.58)

* Upper values are marginal utility, lower values in parentheses are total utility, which is the sum of that cell and the cells to the left.