STRATEGIC MULTIMODAL PERFORMANCE MEASUREMENT: A SURVEY OF BEST PRACTICES AT STATE DEPARTMENTS OF TRANSPORTATION

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STRATEGIC MULTIMODAL PERFORMANCE MEASUREMENT: A SURVEY OF BEST PRACTICES AT STATE DEPARTMENTS OF TRANSPORTATION

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LIST OF SYMBOLS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
CPI	Consumer Price Index
DDOT	District [of Columbia] Department of Transportation
DOT	Department of Transportation
FDOT	Florida Department of Transportation
GDOT	Georgia Department of Transportation
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
FTP	Florida Transportation Plan
ISTEA	Intermodal Surface Transportation Efficiency Act
LOS	Level-of-Service
LRSTP	Long-Range Statewide Transportation Plan
MAA	Maryland Aviation Administration
MAP-21	Moving Ahead for Progress in the 21st Century
MDOT	Maryland Department of Transportation
MDTA	Maryland Transportation Authority
MICA	Multimodal Investment Choice Analysis
MnDOT	Minnesota Department of Transportation
MPO	Metropolitan Planning Organization
MTA	Maryland Transit Administration

MTP	Maryland Transportation Authority
MVA	[Maryland] Motor Vehicle Administration
NCDOT	North Carolina Department of Transportation
ODOT	Oregon Department of Transportation
SFY	State Fiscal Year
SHA	[Maryland] State Highway Administration
SIS	Strategic Intermodal System
SOV	Single Occupant Vehicle
STIP	Statewide Transportation Improvement Program
TD	Transportation Disadvantaged
TCQSM	Transit Capacity and Quality of Service Manual
TIP	Transportation Improvement Program
USDOT	United States Department of Transportation
V/C	Volume-to-Capacity Ratio
WSDOT	Washington State Department of Transportation
WTP 2030	Washington Transportation Plan 2030

SUMMARY

As a result of the increasing demands on and shrinking funds for the nation's transportation system, state departments of transportation (DOTs) have placed a greater emphasis on allocating their limited resources in the most optimal manner. Since passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, transportation planners have identified two promising fields that can assist transportation agencies in optimizing resource allocation decisions-- performance-based planning and multimodal planning. At the intersection of these two fields, and specifically the incorporation of multimodal planning into performance-based planning, is strategic multimodal performance measurement, the topic of this thesis.

Specifically, the thesis set out to identify best practices and recent innovations in strategic multimodal performance measurement within state Departments of Transportation (DOTs). The research involved three main phases, each building on the next. First, a review of the existing literature into current DOTs use of performance measures was carried out. Second, this review activity was supplemented by an assessment of the empirical evidence gathered from a 2012 nationwide survey of multimodal planning practices within state DOTs, including a number of questions targeted towards multimodal performance measurement. In total, 34 state DOTs provided useable information from the survey. Third, and drawing on first two activities, five leading state DOT's were selected for more in-depth analysis of their multimodal performance measurement programs.

Specifically, the following set of six criteria identified by the literature was used to assess each state's performance measurement practices:

- **Strategically Aligned**. Performance measures should flow directly out of an agency's mission and objectives
- **Balanced**. Performance measures should provide a balanced picture of an agency's activities and utilize input, output, and outcome measures.
- **Manageable**. An effective performance measurement system will have a few, well-defined measures tied to a handful of clear goals.
- **Calculable.** Performance measures should use reliable and available data that the agency can collect without straining its resources. Measures should be capable of being measured, of being measured over time, and of being forecasted.
- **Readily Communicable.** Performance measurement reporting and communication should be clear and easy for decision makers and the public to understand.
- **Multimodal.** Both mode-neutral and mode-specific performance measures should be tracked to gauge the total effects on the system and the specific deficiencies in individual modes

The five state DOTs selected for in-depth assessment are Florida, North Carolina, Maryland, Minnesota, and Washington. These case studies are based on the content of a state DOT's publicly available planning and performance measurement documents. These documents were used to evaluate the performance measurement programs at each of the state DOTs with respect to the six evaluation criteria identified above.

Summarizing the findings of the literature review, nationwide DOT survey, and case studies, this thesis shows that leading state DOTs have had some real success since ISTEA in strategically aligning their performance measurement programs to incorporate non-highway modes, while also heeding the call for greater transparency and

accountability through effective performance communication. However, it is also concluded that state DOTs are still struggling with other areas important to a multimodal performance measurement program. In particular, the leading state DOTs are still struggling to develop measures for environmental stewardship, economic development, and quality of life considerations. Also, although states have been incorporating many non-highway performance measures into their strategic performance measure sets, measures for non-highway modes still lag behind highway modes with regard to research, development and data collection activities. State DOTs collectively have not as yet adopted a consistent and compelling methodology for direct, data driven cross-modal comparisons; although the use by some DOTs of analogous rating systems, notably through the use of level of service (LOS) measures, appears to be a promising line of development.

CHAPTER 1

INTRODUCTION

In the U.S., growth in travel demand has outpaced system expansion. This has caused traffic congestion to become a mounting issue over the last several decades. In 2011, the nation experienced a total of 5.52 billion hours in travel delay that resulted in 2.9 billion gallons of wasted fuel and 121.2 billion dollars in congestion costs for commuters (1). Since 1982, indicators of congestion have grown worse, reaching a peak in 2007. Although congestion has improved over the last six years due to the economic recession, the long term forecasts show the levels of congestion worsening again once the economy improves. The mitigation of this worsening congestion will require significant investment of capital into the nation's transportation infrastructure (1). The problem is, however, that this degradation of the nation's transportation system has occurred against the backdrop of a transportation funding crisis. State revenues have been failing to keep up with increasing construction costs and growing travel demand, and there is no relief in sight. This funding shortfall is expected to leave the nation with $1 trillion dollars of unfunded transportation system improvements through 2015 (2). Given the growth in travel demand and decline in buying power of state transportation revenues, the transportation industry has looked to performance-based planning and multimodal planning as a way of optimizing the allocation of the scant funding available to meet the nation's transportation needs.

Understanding these issues, Congress, through the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), required state Departments of Transportation (DOTs) to consider all modes of transportation in the development of state

plans and emphasized using information on transportation system performance to guide decision making. The most recent federal transportation legislation, Moving Ahead for Progress in the 21st Century (MAP-21), continued the legacy of ISTEA by maintaining the requirements for multimodal planning and instituting a new set of requirements for performance-based planning. While states have made significant progress in measuring performance within modes (particularly highways), they have had limited success in incorporating a multimodal perspective into their performance measurement programs. Therefore, the objective of this thesis is to identify current and best practices of strategic multimodal performance measurement at state DOTs in order to provide guidance to state DOTs that are looking for ways to incorporate the consideration of all modes into their performance measurement program. In order to do this, the thesis begins (Chapter 2) by examining the existing literature regarding performance measurement and multimodal planning at state DOTs. The review resulted in the development of a set of six criteria for evaluating the success of strategic multimodal performance measurement at state DOTs along with the identification of state DOTs with a strong foundation in multimodal planning and performance measurement. These six criteria require performance measurement to be strategically aligned, balanced, manageable, calculable, readily communicable, and multimodal. The thesis then examines the results of a 2012 nationwide survey of multimodal practices at state DOTs, with an emphasis on questions directed towards multimodal performance measurement. The results of the literature review and nationwide survey were then used in the selection and in-depth qualitative assessment of five different state DOT performance measurement programs. These case studies (of the Florida, North Carolina, Maryland, Minnesota, and Washington DOT

strategic performance measurement programs) are reported in Chapter 4 of the thesis. Finally, Chapter 5 of the thesis is used to synthesize the results of these case studies into a set of conclusions and recommendations that state DOTs can make use of in the future development of their strategic multimodal performance measurement programs.

CHAPTER 2

LITERATURE REVIEW

This chapter presents the results of a review of the existing literature on the topic of strategic performance measurement at state departments of transportation, with a particular emphasis placed on the multimodal nature of these performance measurement programs. The purpose of the literature review is three-fold: to identify what work has already been undertaken, to develop a framework for evaluating the success of a strategic multimodal performance measurement program, and to identify states that have experienced success in the fields of strategic performance measurement and/or multimodal planning. The review of the literature is organized based on two areas of focus. First, the literature pertaining to multimodal planning and the application of performance-based planning in a multimodal context is discussed, and then the broader literature pertaining to performance-based planning is covered.

2.1 Statewide Multimodal Planning

This section of the literature review will examine literature related to multimodal transportation planning at a statewide level. First, the federally mandated transportation planning process will be discussed with particular emphasis given to the responsibilities of the state DOTs. Next, the concept of multimodal transportation planning will be explained and contrasted with conventional transportation planning. Finally, literature pertaining to current efforts in making comparisons across transportation modes, an important component of multimodal planning, is examined.

2.1.1 Transportation Planning Process

The Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) describe transportation planning as "a cooperative process designed to foster involvement by all users of the system, such as the business community, community groups, environmental organizations, the traveling public, freight operators, and the general public, through a proactive public participation process conducted by the Metropolitan Planning Organization (MPO), state Department of Transportation (state DOT), and transit operators" (3). Figure 1 depicts a generalized framework of the transportation planning process. The green boxes indicate the steps in the transportation planning process and the black arrows depict the sequence of the steps.

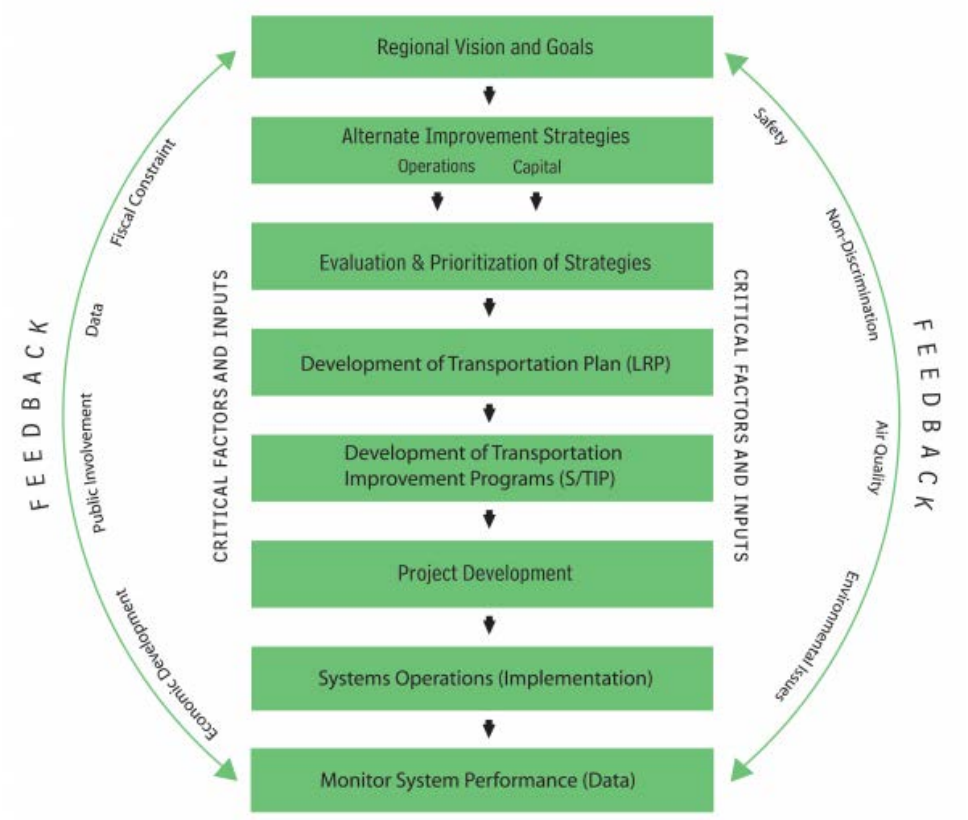


Figure 1: Generalized Framework of the Transportation Planning Process (3)

First, the vision and goals are established for the region and alternative improvement strategies for meeting the vision and goals are developed. These alternative improvement strategies are then evaluated and prioritized based on their ability to assist the region in attaining the established vision and goals. Next, a long-range transportation plan (typically policy-based) is developed. This long-range transportation plan then influences the creation of a short-term transportation improvement program, which specifies transportation projects that have been selected for programming. Finally, the selected projects are developed and implemented and the performance of the system is monitored. The feedback loop shown on the sides of the flow chart demonstrates that the regional vision and goals and the system performance have a mutual influence on each other. Changes in system performance can prompt a change in the regional vision and goals, and a change in regional vision and goals can prompt a change in system performance (3).

In practice, two documents are produced by state DOTs because of this transportation planning process: the long-range statewide transportation plan (LRSTP) and the statewide transportation improvement program (STIP). The LRSTP has a time horizon of 20 years and has no specified requirements for updates. LRSTPs vary from state to state, but they typically include future policies or projects, 20-year projections for travel demand, a consideration of all transportation modes, land use and environmental considerations, financial analyses, and system preservation methods. The STIP has a time horizon of four years and the state DOTs are required to update the STIP every four years. The STIP includes a financially constrained list of projects programmed for funding that are selected based on an adopted evaluation procedure (3).

2.1.2 Multimodal Transportation Planning

Litman (4) identified two distinct approaches for carrying out the transportation planning process: conventional transportation planning and multimodal transportation planning. Conventional transportation planning emphasizes the maximization of vehicular traffic speeds, the minimization of traffic congestion, and the minimization of traffic incidents. Additionally, a number of analysis tools have been developed to support conventional transportation planning because the approach is quite established. Despite these mature tools, the conventional transportation planning approach typically only considers the use of roadway expansion to mitigate traffic congestion, and, therefore, creates a transportation system and land use patterns that cause automobile dependence. Automobile dependence has many negative impacts upon society. It increases traffic and associated costs for drivers, and puts non-drivers at a disadvantage, both socially and economically. It also places pressure on citizens to purchase vehicles and makes it difficult to revoke driving privileges from unqualified drivers. From a practitioner's perspective, it reduces the array of solutions available to address transportation problems, which can lead to less than optimal transportation solutions (4).

Seeing the shortcomings of the conventional transportation planning approach, transportation planning has turned to a new approach, multimodal transportation planning, which considers all modes of transportation and the connections between the modes. The shift to multimodal planning has placed a larger focus on bolstering non-highway modes of transportation and has prompted the use of a more holistic approach to the evaluation of transportation projects. This more holistic approach attempts to account for impacts of the transportation system that are often ignored by conventional

transportation planning (4). Table 1 shows the impacts of the transportation network that are typically considered and also often overlooked by the conventional approach. .

Table 1: Impacts Considered/Overlooked in Conventional Transportation Planning (4)

Usually Considered	Often Overlooked
Financial costs to governments	Generated traffic and induced travel impacts
Vehicle operating costs (fuel, tolls, tire wear)	Downstream congestion
Travel time (reduced congestion)	Impacts on non-motorized travel (barrier effects)
Per-mile crash risk	Parking costs
Project construction environmental impacts	Vehicle ownership and mileage-based depreciation costs.
	Project construction traffic delays
	Indirect environmental impacts
	Strategic land use impacts (sprawl versus smart growth)
	Transportation diversity and equity impacts
	Per-capita crash risk
	Public fitness and health impacts
	Travelers' preferences for alternative modes (e.g., for walking and cycling)

Some of the impacts have been ignored because they are difficult to quantify, like environmental and public health impacts, while others, like user costs for parking and vehicle ownership, have been ignored out of convention. Multimodal transportation planning attempts to account for the impacts that are often ignored by conventional planning; however, it has been a challenge to account for impacts that are difficult to quantify (4).

Another challenge for multimodal planning is the comparison of the various transportation modes. Each mode of transportation has very different characteristics with respect to speed, density, accessibility, cost, and appropriateness of use, among other factors. See Table 2. Given the differing strengths and limitations of each mode, it is very difficult to compare modes because they are not direct substitutes for one another (4).

Table 2: Characteristics of Various Transportation Modes (4)

Mode	Availability	Speed	Density	Loads	Costs	Potential Users			Limitations	Appropriate Uses
	Portion of locations and times served	typical speeds	space requirements	ability to carry baggage	user costs	Non-Drivers	Poor	Handi-capped		
Walking	Wide (nearly universal)	2-5 mph	High	Small	Low	Yes	Yes	Varies	Requires physical ability. Limited distance and carrying capacity. Sometimes difficult or unsafe.	Short trips by physically able people.
Wheelchair	Limited (requires suitable facilities)	2-5 mph	Medium	Small	Med.	Yes	Yes	Yes	Requires suitable sidewalk or path. Limited distance and carrying capacity.	Short urban trips by people with specific physical disabilities.
Bicycle	Wide (feasible on most roads and some paths)	5-15 mph	Medium	Small to medium	Med.	Yes	Yes	Varies	Requires bicycle and physical ability. Limited distance and carrying capacity.	Short to medium length trips by physically able people on suitable routes.
Taxi	Moderate (in most urban areas)	20-60 mph	Low	Medium	High	Yes	Limited	Yes	High costs and limited availability.	Infrequent trips, short and medium distance trips.
Fixed Route Transit	Limited (major urban areas)	20-40 mph	High	Small	Med.	Yes	Yes	Yes	Limited availability. Sometimes difficult to use.	Short to medium distance trips along busy corridors.
Paratransit	Limited	10-30 mph	Medium	Small	High	Yes	Yes	Yes	High cost and limited service.	Travel for disabled people.
Auto driver	Wide (nearly universal)	20-60 mph	Low	Medium to large	High	No	Limited	Varies	Requires driving ability and automobile. Large space requirements. High costs.	Travel by people who can drive and afford an automobile.
Ridesharing (auto passenger)	Limited (requires motorist, matching services)	20-60 mph	High	Medium	Low	Yes	Yes	Yes	Requires cooperative motorist. Consumes driver's time if a special trip (chauffeuring).	Trips that the driver would take anyway (ridesharing). Occasional special trips (chauffeuring).
Carsharing (vehicle rentals)	Limited (requires nearby services)	20-60 mph	Low	Medium to large	Med.	No	Limited	Varies	Requires convenient and affordable vehicle rentals services.	Occasional use by drivers who don't own an automobile.
Motorcycle	Wide (nearly universal)	20-60 mph	Medium	Medium	High	No	Limited	No	Requires riding ability and motorcycle. High fixed costs.	Travel by people who can ride and afford a motorcycle.
Telecommute	Wide (nearly universal)	NA	NA	NA	Med.	Yes	Varies	Varies	Requires equipment and skill.	Alternative to some types of trips.

Despite the differences in the modes, there have been a number of efforts undertaken to facilitate across-mode comparisons. The following sections attempt to capture the most popular methods proposed to date for conducting cross-modal comparisons.

2.1.2.1 Mode-Neutral Performance Measures

NCHRP Synthesis 286 (5) noted that states have struggled in developing performance measures that can be used across modes; however, the synthesis did note a few performance measures that have the potential to be used in cross-modal comparisons and identified a number of states that have made progress in developing such measures. See Table 3. The first column identifies the performance measure, the second explains possible sources of the data, the third column lists the advantages in using the performance measures, and the final column describes the drawbacks to using such measures (5).

Table 3: Potential Measures for Cross-Modal Comparisons (5)

Performance Measure	Possible Methods of Generating Measure	Advantages	Disadvantages
Change in person hours of travel	Should come from transportation model, but some models are not well equipped to generate information. Need good mode choice model.	Provides information on a person basis; uses time as core comparative factor.	Does not account for some of the intangibles. Time is important, but is not everything. Calculation of PHT can be difficult.
Change in vehicle miles of travel	Standard output of transportation model, but needs good mode choice model to estimate transit impact. TDM impact may need to be approximated.	Good measure of impact on vehicle usage, which also relates to air quality and energy.	Need to estimate transit VMT to provide a complete analysis.
Change in mode split to specified zones or on a regional basis	Regional trips by mode are normally available from mode choice model. Zone-specific mode split can be estimated with special runs.	Measure is easy to understand.	Often, differences are relatively small.
Percentage of employees or residents accessible to transit	Requires more of a GIS approach rather than a travel demand model.	Relatively easy to calculate if GIS coverages are available of transit lines, population, and employment; otherwise, can be tedious.	Does not factor in accessibility to destinations. Highway improvements can affect measure, but usually only by a small amount.
Economic measures (e.g., benefit/cost ratio or net present value)	Derived from PHT and cost data.	Brings both benefit and cost data together into a single measure. Incorporates differential values of time (e.g., trucks versus cars).	Does not take nonquantifiable benefits into account; may oversimplify the situation.
VMT per capita	Derived from VMT and population.	Is becoming a benchmark for comparing interaction of land use and transportation system.	Essentially provides same information as VMT, assuming constant population for all alternatives.

GIS = geographic information system; TDM = transportation demand management; VMT = vehicles miles traveled; PHT = person hours of travel.

Among the states making progress in developing mode-neutral measures are California, Florida, Maryland, Minnesota, and Oregon. California identified several potential mode-neutral performance measures and grouped them into a number of goal categories. For each of the measures, the formula for calculating the measure was defined and necessary data sources for each of the modes were identified. Table 4 shows the table of mode-neutral measures identified by California (5).

Table 4: California's Potential Mode-Neutral Performance Measures (5)

Person Movement				Data Needed by Modal Source				
Performance Measure Group	Measure	Formula		Highway	Air	Rail	Water	Transit
Mobility	Mobility index	PMT/VMT × average speed		Vehicles, distance, speed, occupancy	Vehicles, distance, speed, occupancy	Vehicles, distance, speed, occupancy	Vehicles, distance, speed, occupancy	Vehicles, distance, speed, occupancy
	Level of service link	Volume/capacity		Highway demand, lanes	N/A	Track versus number of tracks	N/A	Passengers' seats
	Lost time	Actual time - theoretical time		Actual speeds, posted speeds	N/A	Free-flow travel time, actual travel time	N/A	Actual speeds, posted speeds
Financial	Cost to service provider	(Capital Costs)/(Useful Life) + (Annual Operating Costs)/ Person Miles		Maintenance, repair, liability, capital, operating depreciation	Fuel, maintenance, repair, liability, capital, operating depreciation	Fuel, maintenance, repair, liability, capital, operating depreciation	Fuel, maintenance, repair, liability, capital, operating depreciation	Fuel, maintenance, repair, liability, capital, operating depreciation
	User costs	User costs/person miles		Fuel, insurance, repairs, maintenance, capital, depreciation	Fares	Fares	Fares	Fares
Environmental	Pollution	Pollution/person miles		Pollutants, distance, persons	Pollutants, distance, persons	Pollutants, distance, persons	Pollutants, distance, persons	Pollutants, distance, persons
	Greenhouse emissions	CO_2/person miles		CO_2/person miles	CO_2/person miles	CO_2/person miles	CO_2/person miles	CO_2/person miles
	Fuel consumption	Fuel/person miles		Fuel/person miles	Fuel/person miles	Fuel/person miles	Fuel/person miles	Fuel/person miles
Economic	Average jobs supported per year	(Capital Costs*)/ (Useful Life)	Capital employment multiplier	Operating expenditures, capital costs, useful life, employment multipliers	Operating expenditures, capital costs, useful life, employment multipliers	Operating expenditures, capital costs, useful life, employment multipliers	Operating expenditures, capital costs, useful life, employment multipliers	Operating expenditures, capital costs, useful life, employment multipliers
		Annual* + operating costs	Operating employment multiplier					
	GSP impacts	(Capital Costs*)/ (Useful Life)	Capital GSP multiplier	Operating expenditures, capital costs, useful life, GSP multipliers	Operating expenditures, capital costs, useful life, GSP multipliers	Operating expenditures, capital costs, useful life, GSP multipliers	Operating expenditures, capital costs, useful life, GSP multipliers	Operating expenditures, capital costs, useful life, GSP multipliers
		Annual* + operating costs	Operating GSP multiplier					
Safety	Accidents	Accidents/person mile		Accidents, person miles	Accidents, person miles	Accidents, person miles	Accidents, person miles	Accidents, person miles

N/A = not available; PMT = person miles traveled; VMT = vehicle miles traveled; GSP = gross state product.

Florida is studying the use of person throughput and average travel time as potential mode-neutral measures and is currently using public transit trips, transit ridership growth compared to population growth, percent of single occupant vehicle (SOV) work trips, and employees using carpools statewide as indicators for the state goal of reducing SOV dependence. Oregon has incorporated multimodal measures in its transportation plan, notably the percent of citizens commuting fewer than 30 minutes, the percent commuting by non-SOV, transportation related fatalities per 100,000 people, and the percent of citizens living in communities meeting air quality standards (5).

2.1.2.2 Multimodal Level of Service

Another emerging trend that may be useful for making comparisons across modes is the use of level-of-service (LOS) ratings for all modes of transportation. LOS, which is typically rated on a scale of A through F, much like school grades, is used in transportation planning to evaluate the quality of a transportation facility. Because of the familiar scale, LOS is easily understood by decision makers and the public alike. Conventional planning has used LOS strictly for roads to represent vehicle speeds and delay through the use of the volume-to-capacity ratio (V/C), a measure of the portion of the roadway's designed capacity being used. Until the past decade or so, this approach was focused on highways, thus promoting the use of roadway expansion as the only solution for addressing transportation problems (6). In recent years, however, recognizing the potential for this easy-to-understand rating scale in facilitating modal comparisons, transportation planners have started to develop level-of-service measures for non-highway modes as well (6).

For example, for the Association of American Railroads (AAR), Cambridge Systematic Inc. developed an A to F LOS measure based on the nation's Class I freight rail network traffic volume-to-available capacity measure as a means of assessing the future rail system capacity investment needs (7). The Florida Department of Transportation (FDOT) has also developed a handbook and software for determining the passenger mode LOS for automobiles, bicycles, pedestrians, and buses, all of which use the A to F scale. FDOT decided that the Bicycle LOS Model developed by Landis (8) was the best methodology for determining bicycle LOS. This methodology considers the average width of the outside through lane, the vehicle volumes, vehicle speeds, truck volumes, and pavement conditions. A calculation incorporating each of these variables is used to calculate a score that is then classified into a LOS rating. FDOT determined that the best model for calculating pedestrian LOS is the Pedestrian LOS Model, also developed by Landis (9). The Pedestrian LOS Model uses the same process as the Bicycle LOS Model, except it considers vehicle speed, vehicle volume, existence of a sidewalk, and the lateral separation of the sidewalk from vehicles in the calculation of the LOS score. The leading LOS methodology for buses identified by FDOT comes from the Transit Capacity and Quality of Service Manual (TCQSM). The methodology outlined by the TCQSM classifies transit LOS based solely on the service frequency in vehicles per hour (10).

However, while all of these measures are based upon the same rating scale, FDOT explicitly warns against using these measures to compare across modes, because the designations are not consistent across modes (10). Given this issue, more work must be

done in this area to create a scoring or classification system that attempts to facilitate cross modal comparisons before this technique can be used for tradeoff decisions.

2.1.2.3 Economic Reductionism

Performance measures have been developed and used to measure the outcomes of agency activities in a number of areas: accessibility, mobility, safety, environment, economic development, energy consumption, and quality of life considerations, among others. These performance measures have also been developed to reflect the performance of different modes for each of these areas. Given the diversity in the outcomes that performance measures indicate, it is only natural that the units of measurement used for these performance measures also vary. There are three basic "terms" in which performance is measured: monetary terms (e.g. travel time cost savings), where impacts are converted to monetary values; quantified terms, where impacts are quantified but not converted into monetary value (e.g. reduction in highway fatalities); and qualitative terms, where impacts cannot be quantified (e.g. quality of life considerations). According to Weisbrod, Lynch, and Meyer, "the diversity in units of measures, poses a serious challenge in performing tradeoffs across modes or programs" (11). An emerging solution to this challenge is economic reductionism, the conversion of the quantified terms and qualitative terms into monetary terms. By putting all impacts of the transportation alternatives into monetary terms, alternatives of all different modes may be compared. Although the idea of monetizing all impacts appears to be simple and straightforward, there are a number of challenges associated with applying this approach. While most agencies are familiar with monetizing mobility, operations, efficiency, freight transportation, and system preservation, agencies have not quite agreed on how to

monetize environmental, safety, and economic development impacts, largely as a result of the controversy behind assigning a valuation for pollution, deaths, and economic development, respectively. Agencies have also made little progress in monetizing land use, quality of life, and social equity impacts. As a result of these challenges, economic reductionism is not as widely used as it might otherwise be for decision-making purposes (11).

2.1.2.4 Multimodal Tradeoff Analysis

Recently, a significant amount of focus has been given to the field of multimodal tradeoff analysis. Multimodal tradeoff analysis is an analytical process that can assist decision makers in resource allocation decisions by providing them with information regarding the tradeoffs between alternative funding scenarios for multiple programs or transportation modes. Cambridge Systematics Inc. has developed a framework for conducting multimodal tradeoff analyses that is composed of a vertical component within modes and programs and a horizontal component across modes and programs (12). The framework outlines a five-step process: develop criteria for analysis across programs, develop criteria for analysis within programs, identify programs to be considered, apply inter-program and intra-program analysis tools, and present the results of the tradeoff analysis.

The first step in the process requires the agency to establish comprehensive vision, goals, and performance measures with a "broad, systemwide perspective" to be used by decision makers to guide agency action (12). This practice of measuring performance of all modes and relating it to the system was named system performance measurement in the report from the Volpe Center (13). The Volpe Center

report also identified a number of states that were implementing this approach. Some states included these system performance measures in their long-range plans, most notably California, Rhode Island, and Michigan, while others who were undertaking systems performance in performance reports not included in their long range plans (e.g. Washington, Missouri) (13). The second step of the framework is developing performance measures for within programs or modes. As noted above, here the development of performance measures and collection of data for the highway system is much more robust than for the other transportation modes (12).

The third step in the process is simply identifying the program areas or modes that will be compared in the tradeoff analysis, and should ideally contain all modes the agency has responsibility for (12).

The fourth step in the tradeoff analysis framework is the application of analytical tools or procedures to obtain tradeoff information for alternative funding scenarios. This step is broken down into a number of sub-steps: measurement of current performance, identification of alternative future funding scenarios, analysis of future performance for individual programs under alternative funding scenarios, and analysis of system wide impacts of alternative funding scenarios (12). There have been many efforts at developing tools to prioritize projects and programs by predicting the performance implications of alternative funding strategies. Spence and Tischer outlined a number of methodologies for undertaking such an analysis: mode-neutrality, benefit-cost analysis, least cost planning, cost-effectiveness analysis, and multicriteria evaluation (14). The least cost planning method entails selection of the alternative which satisfies a prescribed performance level for the lowest cost, and the cost effectiveness model ranks projects on

the amount of cost per unit of performance achieved (e.g. cost per person trip traveled) (14). Oregon DOT is also currently developing a least cost planning methodology that is scheduled to be ready at the end of 2013 (15). The mode-neutral methodology requires a set of performance measures that are not mode-specific and can be applied to all modes, however, *as noted before* there has been limited success in developing such measures that are meaningful across modes. The multicriteria evaluation method uses multiple evaluation criteria that are weighted and ranked based on a scoring model. This method was used in the development of TransDec, a model that evaluates how well transportation investments achieve a set of performance standards. The method that has seen the most success in tool development, however, is the benefit-cost methodology, where benefits in performance are monetized and compared in a single ratio with the cost of the action. The USDOT has developed HERS-ST, NBIAS/NBI, and TERM/NTD to evaluate improvements resulting from highway, bridge, and transit investment, respectively. These tools are feasible for single modes only and, therefore, do not fulfill the requirement for comparing across programs. However, there has been some work towards a tool capable of comparing across modes. The Multimodal Investment Choice Analysis (MICA) uses a combination of the cost-benefit and multicriteria evaluation methodologies and is a promising tool that may assist in analyzing the impacts of investment scenarios across modes. This tool has yet to be applied successfully, however.

Other promising tools that may assist in the evaluation of performance across modes are the United States Department of Transportation (USDOT) models SPASM and STEAM, which are capable of analyzing the effects of demand management strategies

and multimodal investments, with SPASM being the project level tool and STEAM being the system level tool (14).

The final step in the tradeoff framework is the presentation of the information developed in the fourth step. This step is critical as it informs decision makers about the tradeoffs that will occur because of their choices (12).

In order for state DOTs to be able to successfully perform the multimodal tradeoff analysis conceptualized by Cambridge Systematics Inc., more work needs to be done in collecting data and developing performance measures for non-highway modes, creating and refining system performance measurement programs, and developing analytical tools to compare alternative investment decisions across modes (14) (16) (17).

There is no evidence in the literature to suggest that any states have been particularly successful in performing multimodal tradeoff analysis. In fact, Spence and Tischer noted this when they described multimodal tradeoff analysis as the "state of the art" and explained that the "state of the practice" was the use of performance measures to "examine the transportation system and identify areas of deficiency" (14 pp. 3,7). Seeing that there has been limited activity by state DOTs in multimodal tradeoff analysis, this thesis will focus on current practices at state DOTs in including all modes of transportation into the strategic performance measurement program.

2.2 Performance-Based Planning

This section of the literature review will focus on performance-based planning. In this section, the incorporation of performance measurement into the transportation planning process is explained and the motivations and benefits for carrying out performance-based planning are identified. Then, the guidance in the literature on how to

develop and undertake performance-based planning is discussed, and, finally, literature highlighting current practices in performance-based planning both abroad and in state DOTs in the U.S. are identified. The review of the literature in this and the previous section results in the development of a set of criteria for evaluating the success of strategic multimodal performance measurement programs at state DOTs.

2.2.1 Motivation for Performance-Based Planning

The transportation field has been moving towards performance-based planning for a number of years, prompted by a number of factors. Among these were:

- the 1991 ISTEA legislation (which stressed the need for a multimodal approach to transportation planning),
- the need for the most efficient use of transportation funding in an era of scant funding resources,
- the importance placed on supporting economic competitiveness through transportation investments (particularly in freight),
- environmental legislation,
- the emphasis placed on addressing social concerns through transportation investments,
- the introduction of growth and congestion management and other strategies that account for the transportation/land use interaction, and
- the introduction of new technologies that offer innovative solutions to transportation problems (18).

Building on these developments, and in the process focusing more attention of performance measurement, a new set of issues has reignited interest in performance-based planning at state DOTs in recent years. Pei, et al. identify these latest issues as:

1. the need for more information in strategic planning processes,
2. the increasing demands for transparency and accountability,
3. the shift by state DOTs to a customer-oriented approach, and
4. the recent (2012) reauthorization of the surface transportation program, MAP-21 (19).

These four issues are discussed in detail in the following sections.

2.2.1.1 Supporting Strategic Planning

Strategic planning is the ongoing process of defining an agency vision, identifying goals that relate to the agency vision, and guiding agency activities towards achieving these goals. Strategic performance measurement combines the practice of strategic planning with performance measurement to link the agency's high-level goals with the measurable outcomes of everyday activities. While the benefits of strategic performance measurement are many, the literature pointed out that few state DOTs partake is such activities. States that do partake in strategic performance measurement typically include their documentation in one of two media: a strategic plan or their federally mandated long range transportation plan. In these documents, the agency vision is established, goals and objectives are developed, and strategically aligned performance measures are identified. Performance measurement is vital to strategic planning because it can help shape

organizational culture, focus an agency's staff on priorities, and provide necessary information to decision makers (20).

2.2.1.2 User-Orientation

Another shift in the transportation sector since the passage of ISTEA has been to a more user-oriented approach to planning, which emphasizes user satisfaction and perception in the evaluation of transportation investments. This approach to performance measurement has the potential to reconcile the differences in what a transportation agency believes to be important and what the users of the transportation system value (18). The literature has identified an important caveat to this reliance on customer input, however. The use of customer opinion surveys alone is not sufficient because users tend to focus on improving the current network and do not have the necessary long-range perspective. Seeing this, the literature suggests that survey-based measures be accompanied by system performance measures to create a more balanced perspective (21).

2.2.1.3 Transparency and Accountability

Attendees of the 2001 Conference on Performance Measures to Improve Transportation Systems and Agency Operations identified the increased accountability demands on government agencies to be one of the more important trends in performance-based planning (21). This trend will require transportation agencies to enhance the communication of agency performance with external stakeholders. Bremmer, et al. (22) pointed out that this push for state DOTs to become more accountable and transparent is largely a result of political pressure, and that this pressure affects how performance measurement programs are carried out at state DOTs. So far, state DOTs have responded

in a number of ways to this mounting political pressure. One such response is a change from the traditional performance-based planning framework to a more flexible framework where the suite of performance measures used by an agency is adapted for three distinct audiences: legislative bodies and oversight committees, the media and general public, and internal managers. Another emphasis of state DOTs in meeting the demands for transparency and accountability has been on communicating performance in a more effective manner. With the added emphasis on transparency and accountability, the communication of performance has become as important as the tracking of performance itself (22).

Another area of emphasis among transportation departments is a strengthening of the connection between particular employee performance and overall agency performance measures. This strategy can be applied in two forms: the "soft approach" and the "hard approach" (22 p. 8). The soft approach includes training and meetings to gain employee buy-in for performance-based planning, and the hard approach consists of assigning responsibility for certain performance measures to particular employees and holding them accountable for their efforts (22). Other strategies being used by state DOTs include the use of before and after analyses to demonstrate the benefits resulting from agency activities and performance-based contracts to ensure that work performed by contractors meets the agency's standards (22).

2.2.1.4 Moving Ahead for Progress in the 21st Century Act (MAP-21)

Of all the emerging issues, the one with the ability to create the most change in the field of performance-based planning is the most recent federal legislation, MAP-21. The legacy of performance-based planning that was initiated by ISTEA plays a central

role in MAP-21. The legislation regarding performance-based planning in MAP-21 is separated into three sections; one relating to requirements for MPOs, one relating to state DOTs, and one relating to the creation of national goals and performance measures. As this research is focused on state DOTs, the following discussion looks at the legislation from a state DOT's perspective.

According to the legislation, each state is to adopt a performance-based approach to decision making using a set of performance measures that are being developed in support of a set of USDOT defined national goals. Each state is required to establish its own targets for the measures and must incorporate the performance-based processes undertaken by the agency into the statewide planning process. The new performance-based planning requirements for the long range transportation plan include a description of the performance measures and targets used and a regularly updated system performance report that tracks agency progress towards achieving the agency-set performance targets. The legislation also requires a discussion in the STIP of how the programmed projects are anticipated to affect the agency's progress towards achieving the performance targets included in the long range transportation plan. The reasoning here is that this will link investment strategies to the achievement of strategic goals.

Perhaps the most important component of the performance measurement section of MAP-21 is the establishment of seven national goals. The goals outlined in the legislation are safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, and reduced project delivery delays. The USDOT, after consulting with the state DOTs and MPOs, will release a set a national performance measures by January 2014. States will be

required to set performance targets for each of the prescribed measures no later than a year after the national performance measures are released. The states will then be required to submit a performance report of their own to the USDOT no later than July 2016, and every two years from then on.

The USDOT will establish criteria to evaluate the progress of each state towards meeting its performance targets, the efficiency and cost-effectiveness of investment decisions made by the state, and the extent to which the state achieves transparency and accountability with the public. This legislation will no doubt increase the amount of effort from state DOTs in performance measurement and create a need for guidance in the field of performance-based planning at state DOTs.

While the USDOT has not released a specific set of performance measures to be used, many organizations have offered input on what measures should be included. For example, Table 5 is the list of recommended performance measures being advocated by the American Association of State Highway and Transportation Officials (AASHTO). The left column lists the seven national goal areas, the middle column contains the suggested performance measures, and the right column identifies the MAP-21 program area the performance measure supports (23).

Table 5: National Performance Measures Recommended by AASHTO (23)

National Goal Area	National Performance Measure Areas	MAP-21 Program Area
Safety	1. Serious Injuries per VMT 2. Fatalities per VMT 3. Number of Serious Injuries 4. Number of Fatalities	HSIP HSIP HSIP HSIP
Infrastructure Condition	5. Bridge Condition on the NHS 6. Pavement Condition of the Interstate System 7. Pavement Condition of the NHS (*excluding the Interstate*)	NHPP NHPP NHPP
Congestion Reduction	8. Traffic Congestion	CMAQ
System Reliability	9. Performance of the Interstate System 10. Performance of the NHS (*excluding the Interstate*)	NHPP NHPP
Freight Movement and Economic Vitality	11. Freight Movement on the Interstate	
Environmental Sustainability	12. On-Road Mobile Source Emissions	CMAQ
Reduced Project Delivery Delays	None.	

2.2.2 Benefits of Performance-Based Planning

Cambridge Systematics Inc. (18) recognized that the benefits of adopting performance based planning were considerable. The biggest among these was the improvement of resource allocation decisions that results from incorporating agency goals into the decision making process. They also identified additional incremental benefits that result from performance-based planning. These include:

- the improved linkage of agency goals with the goals of the public,
- enhanced understanding and administration of services within the agency,
- improved strategic planning,
- greater agency accountability that results from reporting performance,
- better-informed decision making by governing bodies, and
- the ongoing reevaluation and fine-tuning of agency programs (18).

2.2.3 The Performance-Based Planning Process

The U.S. Government Performance and Results Act of 1993 established some basic components of performance-based planning when it required federal agencies to develop strategic plans. The basic components include:

- a comprehensive agency mission,
- agency-wide goals and objectives,
- clearly-defined, quantifiable performance objectives,
- performance measures that can accurately portray the performance of agency activities,
- an explanation for how the performance measures relates to the agency goals and objectives,
- a method for reporting results and comparing the results to agency targets,
- a discussion of factors beyond the agency's control which could affect the performance measures,
- and an identification of resources necessary for the agency to achieve its goals (18).

Cambridge Systematics Inc. has developed a framework that integrates these requirements into the traditional transportation planning framework. Figure 2 depicts this new framework for what is called the performance-based planning process. The black ovals in the figure depict each of the steps in the process and the labels on the arrows represent the relationship between these steps in the process. The steps included in the gray box are the elements that were incorporated into the traditional planning process to transform it into a performance-based process.

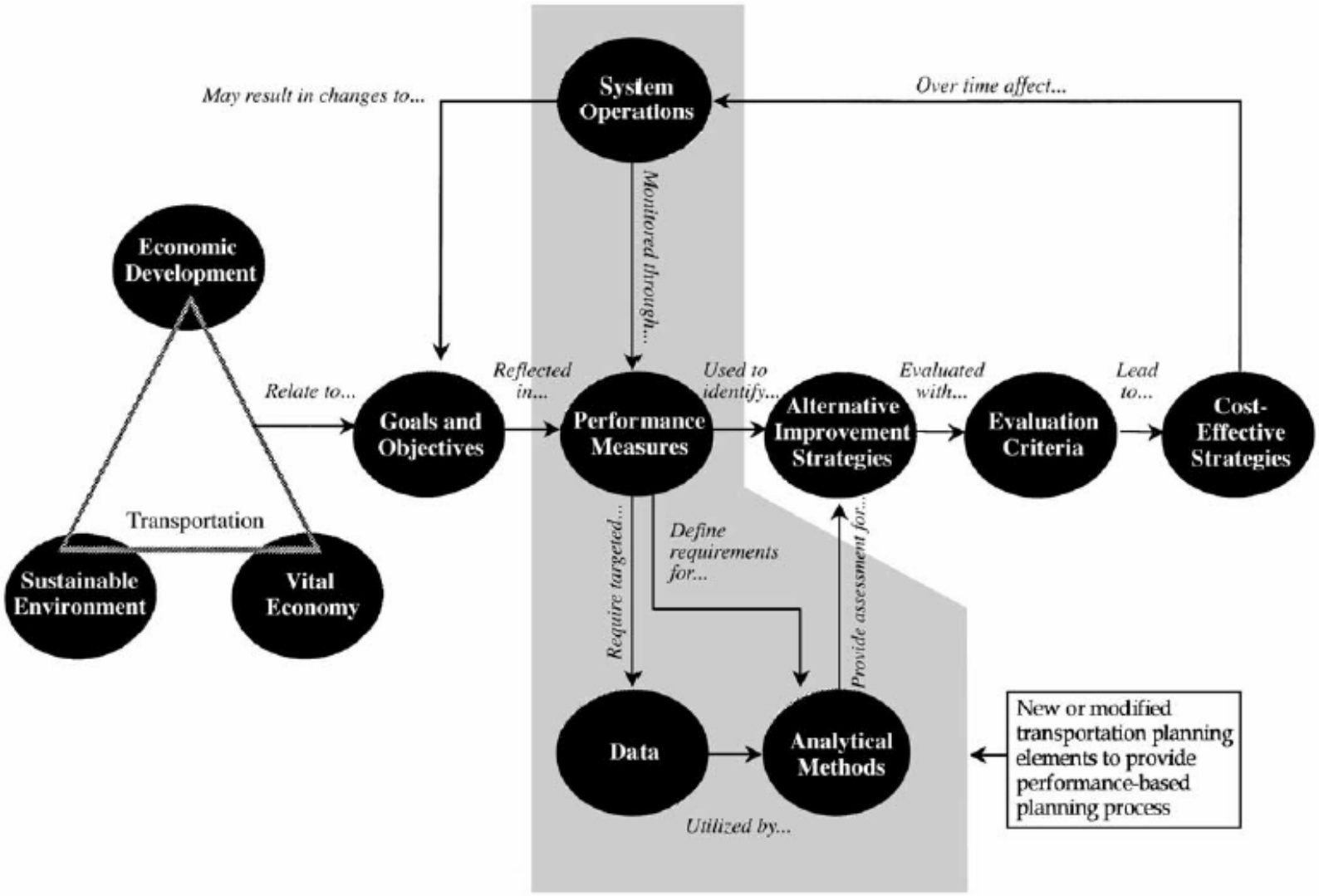


Figure 2: Framework for the Performance-Based Planning Process (18)

The first step in this performance-based planning framework is the identification of broad goals that will allow the agency to achieve its vision and the establishment of objectives, which state the broad goals in a more specific, quantifiable manner. The next step is the development of performance measures that reflect the agency's progress towards attaining the stated goals and objectives in the previous step. The selected performance measures will then assist in the identification of alternative improvement strategies and define the requirements for both data collection and analytical methods. The collected data is then used in the analytical methods to provide information about the alternative improvement strategies. The alternative improvement strategies are then evaluated with a set of evaluation criteria. The information obtained from this evaluation provides decision-makers with support in understanding the likely consequences of their decisions and facilitates a more objective consideration of improvement strategies. This ideally leads to investment in the most cost-effective strategies for meeting the agency's goals and objectives. Over time, these investments will have an impact on the system operations that can be tracked through the performance measures established earlier in the process. The impact on the system operations may also result in a change in the priorities of an agency. This may result in an adjustment of the agency's goals and objectives to reflect the new priorities (24). One element of the performance-based planning process that is not explicitly included in this framework and deserves a great deal of emphasis is the communication of results. The communication of results is important at two points in performance-based planning process: first in the evaluation of alternative improvement strategies, and secondly, in the monitoring of system operations (25).

2.2.4 Guidance for Developing a Performance-Based Planning Program

Cambridge Systematics simplified the framework for a performance-based planning process into five basic steps:

- identification of agency priorities and translation of these priorities into broad goals and measurable objectives,
- determination of the most appropriate performance measures,
- decision on an approach to planning that incorporates these priorities into the decision-making process,
- development of data collection systems to support the calculation of performance measures,
- and the development or identification of analytical tools to calculate usable performance measures from collected data (18).

Another important step in a performance-based planning process that is not included above is the consideration of how results will be reported. The following sections provide the recommendations from the literature on how best to undertake performance-based planning for each of these aforementioned steps.

2.2.4.1 Goals and Objectives

The terms goals and objectives have been used interchangeably and inconsistently at transportation agencies across the country. Bremmer, et al. have pointed out that this inconsistent use of terms in performance-based planning has hindered the communication and sharing of ideas between transportation agencies (22). Seeing this, Cambridge Systematics developed a clear definition for each of these terms in order to eliminate any confusion. They defined a goal as "a general statement of a desired state or ideal function

of a transportation system," and an objective as "a concrete step toward achieving a goal, stated in measurable terms" (18 p. 14). For example, an agency's goal could be to improve safety on the state's roadways and one of the corresponding objectives would be to reduce the number of incidents or fatalities on the state's roadways. These definitions will be adopted and used throughout this paper to provide clarity to the readers.

A second issue in performance-based transportation planning has been the level of detachment between the development of an agency's goals and objectives and the allocation of resources to address these within an agency. This has largely been a result of a lack of data and analytical tools for determining an agency's progress towards achieving these goals and objectives. Therefore, in order to bridge this gap, Cambridge Systematics recommends making goals “operational” so that they can be explicitly linked to specific performance measures that can be calculated (18). Another issue in the development of goals and objectives has been the need to organize them in a way that makes a large number of goals and objectives more manageable.

Categories of Goals and Objectives

In light of the growing awareness of the effect that transportation system investments have on other aspects of society, the transportation industry has taken a more holistic approach to transportation planning. The chief aim of transportation projects in the past, the "movement of people and goods", is now accompanied by a number of other goals that have a relation to the transportation system; for example, issues relating to environmental stewardship, social equity, and economic development, among others, are increasingly being examined by transportation agencies across the country (18 p. 9). This growing list of agency goals is a challenge to agencies attempting to develop a concise

and "manageable" set of performance measures (18). One strategy for managing a large number of goals and objectives is to bundle them together in categories that relate to the core issue they address. According to a review of planning documents and research of planning agencies, Cambridge Systematics identified eight categories of goals and objectives that are widely used and are a solid foundation for developing a performance-based planning process; these categories are accessibility, mobility, economic development, quality of life, environmental and resource conservation, safety, operational efficiency, and system condition and performance (18). It is not surprising that these common categories of goals are present in the national set of goals established in MAP-21.

Pei, et al. developed and distributed a survey for the 50 state DOTs plus the District of Columbia's DOT (DDOT) and received responses from 39. The survey shows that state DOTs organize their goals in three different ways. The most common method DOTs use is the "one tier arrangement" which entails one set of broad goals such as safety or mobility (19). Another way DOTs organize goals is through the "multi-tiered arrangement" where the broad goals of the "one tier arrangement" are accompanied by more clearly-defined objectives that correspond to the broader goals. The third way state DOTs arrange their strategic goals is through the so-called "area-specific manner," where each division or program has its own individual goals with some broad goals overlapping multiple divisions or programs (19).

2.2.4.2 Performance Measures

Performance measures are indicators of the effectiveness of an agency's activities in meeting the agency's goals (18). They should flow directly from the goals and

objectives established by the agency and community and provide decision makers with required information. Seeing how agencies and communities differ, no single set of performance measures is appropriate for all agencies and communities (21).

Performance measures must be carefully selected so that they clearly represent the goals and objectives they are meant to reflect. This is an important step because the selection of particular performance measures will directly affect the allocation of agency resources. If the performance measures do not reflect the agency's goals and objectives, the analysis of alternatives will not produce the most efficient investment scenario. There have been criticisms of performance measures that are inherently biased; for example, it has been argued that the LOS measure is biased towards highway capacity expansion (26). There are also cases where the use performance measures actually undermined the goals of an agency because they did not accurately reflect the goals. This was the case for Florida's growth management initiative where concurrency requirements (a growth management concept intended to ensure that the necessary public facilities and services are available concurrent with the impacts of land development) using LOS actually forced new development to the outskirts of urban areas, driving suburban sprawl (27). In order to mitigate these potential issues, agencies have started to use broader performance measures or multiple performance measures for a particular goal or objective (21).

When selecting performance measures it is important to consider data availability. However, the literature has emphasized that the development of a performance measurement system should be primarily driven by the goals and objectives identified by the agency (21). Agencies that are not readily equipped to implement multiple performance measures are implementing additional performance measures in a "tiered"

approach, where measures are incorporated into a performance measurement system as the data collection programs and analytical tools necessary to support it are developed (18). The literature has shown that many agencies have been successful in using this strategy. These agencies started by introducing a small set of measures and built off early success to develop more robust and comprehensive performance measurement systems (21).

Input, Output, and Outcome

Transportation agencies have a history of using performance measures to capture system inputs and outputs, but have recently placed more emphasis on capturing system outcomes. Here an input measure represents the resources allocated to a particular agency activity or program. An output measure typically represents the amount of "products and services delivered" by a program (19 p. 2). An outcome measure corresponds to the consequences resulting from the products and services delivered by the program (19). For example, an input measure for a transportation agency's ice/snow removal program would be the amount of money budgeted for the program. The corresponding output measure would be the tons of salt applied to roadways. The corresponding outcome measure would be the (hopefully reduced) number of incidents attributed to icy roads. The common thought in the field of performance measurement is that outcome measures are superior to output or input measures because outcome measures are better indicators of the actual progress the agency is making toward achieving its goals. Despite this outlook, the literature emphasizes using a mixture of output and outcome measures to create a balanced perspective of the level of agency activity and its relation to the results of the activity (18) (19) (28).

Classifications

Performance measures can be classified in a number of other ways. Agencies may classify performance measures based on whether they are mode-neutral or mode-specific, whether they are intended for use on passenger facilities or freight facilities, whether they are applied on a system wide basis or for a segment of the system, and who the intended audience is (user vs. agency) (18). Pickrell and Neumann also inferred that performance measures may be classified based on the function they serve. Performance measures used in transportation tend to belong to one of three categories based on their function: measures of system performance, measures of system condition, or measures of organizational performance. Measures of system performance reflect the performance of the transportation system itself. Measures of system condition represent the condition of the assets included in the transportation system. Finally, measures of organizational performance signify internal operations or business processes (25).

Performance Indices/Indicators

The introduction of a large number of performance measures has the potential to overwhelm decision makers and other users of the performance data and detract from the central focus of the performance measurement program. Seeing this, many agencies have attempted to limit the number of performance measures used. A potential strategy for limiting the amount of performance measures used by an agency is the use of "performance indices". Such indices are measures that mathematically combine multiple measures into a single indicator. The use of these performance indices allows agencies to consider a large number of factors while still maintaining a manageable number of performance metrics and a level of simplicity in the decision-making process. An

example of a commonly used performance index is the Consumer Price Index (CPI). The CPI is used to quantify, in a single metric, the effects of monetary inflation by representing the prices of a set of products generally purchased by the ordinary consumer. In the transportation field, there has been significant attention placed on using performance indices for mobility and accessibility, two goals that have a number of important indicators of performance (18). States that have successfully used indices to combine measures include Florida and Ohio (29).

Nesting

Another potential strategy for making large sets of performance measures more manageable is "nesting" (21). A nested design of performance measures includes a small set of strategic performance measures used for high-level decision-making and a larger set of detailed performance measures to be used by front-line employees. A benefit of this design, in addition to transforming a large set of performance measures into a manageable set of key indicators, is that it allows employees at all levels to understand where their activities fit into the larger agency vision (21).

Setting Performance Targets

Rather than simply track a performance measure, some agencies set performance targets to establish a definitive goal for agency outcomes. A performance target is a threshold for the level of performance an agency expects to achieve in a certain program area. An example of such a target would be decreasing the number of fatalities on the state's highways by 10% over the next decade. Setting targets is often a difficult process because agencies without much performance measurement experience struggle with choosing a target that is neither too easy nor too difficult to achieve (30).

In current practice, agencies use three distinct strategies to select targets. One such approach is model-based target setting, where the performance measure is modeled under different policy scenarios, and the results are used to inform the establishment of a reasonable target. This approach, however, is largely dependent on the ability of the model to reflect the real world conditions accurately, as well as the appropriateness of basic assumptions made during the modeling process. The second way in which targets are set is through extrapolation of past data or through the exercise of engineering judgment to estimate an appropriate target. This process requires an agency to have past performance data to use in estimating what an appropriate target should be. The third approach used, called "aspirational" target setting, does not rely on evidence from models or past data to determine targets. Rather, this approach simply sets the target in a normative manner, asking what level of performance should be achieved by the agency (30).

While setting targets has its challenges, the benefits of target setting identified in the literature include increased agency focus on priorities, ease of communication to the public, and the provision of feedback into the administration of programs and activities. Some criticisms of target setting identified in the literature involve the shift of focus away from important programs that are not included in the agency's performance measurement program and the uncertainty experienced in setting reasonable targets (30).

2.2.4.3 Incorporation into the Decision-Making Process

In order for the performance measurement system to improve an agency's allocation of resources, the results of the performance measurement system must be integrated into the agency's decision-making process (21). Typically, transportation

agencies will incorporate performance based-planning into the decision-making processes at many different levels. Included in these levels are policy analysis, long-range regional and statewide plans (the focus of this thesis), selecting and programming projects in the shorter-range transportation improvement programs (TIPs), evaluating alternatives for particular corridors or study areas, trade-off analyses, and systems operations (18) (25). The applications of performance-based planning involved in high-level state DOT management include policy analysis and long-range statewide planning, which are typically documented in strategic plans and/or LRSTPs.

2.2.4.4 Data Needs

Data collection is a resource intensive activity. As such, the most important consideration in developing data collection programs for a performance measurement system is taking full advantage of existing or obtainable data (21). Many agencies already collect a sufficient amount of data, so the improvement of a performance measurement program does not necessarily need to be resource-intensive (31).

Another important consideration discussed in the literature is data sharing among agencies. This is especially important considering the push in the literature towards the use of more multimodal or mode-neutral performance measures. With different agencies sharing responsibility for the different modes and jurisdictions of the transportation network, many data sharing partnerships will be necessary to develop such multimodal or mode-neutral measures (21).

Resources

Many types of data can be collected with regard to the transportation system. Among the different data types are passenger and freight industry surveys, traffic

monitoring data, customer satisfaction data, and GPS, cellular, and other forms of "non-intrusive" electronic data collection. Survey data can provide a wide range of data relating to the user experience and typically relies on statistical methods. Potential survey data collection techniques include household travel surveys, workplace (establishment) surveys, stated-preference surveys, longitudinal and panel surveys, transit on-board surveys, commercial vehicle surveys, external station surveys, and parking surveys. Traffic monitoring data typically includes vehicle speeds, travel times, occupancies, weights, classifications, and counts; these are typically collected from traffic volume counters, vehicle classification recorders, or weigh-in-motion sites. A number of other readily available data sources may also be used by state DOTs. The FHWA oversees the Highway Performance Monitoring System, a database of traffic counts that is used to provide information on highway system condition and performance for state DOTs. Additionally a variety of vehicle tracking data generated by electronic means may be useful in performance measurement, and a growing volume of data relating to freight movements, primarily trucking, is also available to state DOTs (18).

2.2.4.5 Analytical Tools

The collection of data alone is not enough for a successful performance measurement program. Analytical methods and tools are also needed to generate and analyze the raw data. The literature noted that there was a need for the development of analytical tools for multimodal data (17). However, a number of analytical tools that already exist could be used. Among these are urban and statewide travel demand forecasting models, benefit-cost models, tradeoff analysis frameworks, which were

mentioned before in the section on multimodal tradeoff analysis, and various other sketch-planning tools (18).

2.2.4.6 Reporting Results

In an era where political pressure has pushed state DOTs to become more transparent and accountable, the literature identified the communication of performance as a critical component of performance-based planning (22). In order to communicate the results of the performance data effectively, the design of the reporting media must be easily understandable and must provide the data necessary to improve agency decisions (21). Bremmer, et al. outlined two distinct designs agencies have to choose from for reporting performance: dashboard and agency reports. Dashboards efficiently report on the agency's progress in meeting targets by using red, yellow, or green lights to communicated that the agency is not meeting, nearly meeting, or meeting the targets, respectively. Virginia and Minnesota were identified as examples of agencies that use a dashboard to report results. Georgia also uses dashboards to report performance. The other style identified by Bremmer, et al. uses agency reports, sometimes via the internet, to communicate performance. These agencies use this style to make all their performance measures accessible to any interested audience either through report cards or through annual reports that may also be posted on the internet. Washington and Florida are examples of state DOTs that use this agency reports approach. A third style of performance reporting was identified by Poister, as the "scorecard." The scorecard method of reporting is only appropriate for agencies that partake in target-setting, as it entails a list of the performance measures and a comparison of the actual performance levels to the target-performance levels as a way to track agency progress. Pennsylvania

includes this style of performance reporting in its performance reports (29). Another style of performance reporting identified in the literature is called the trend line. These reports include a temporal component to the reporting of performance measures to track the long-term progress of the agency toward meeting established goals and objectives (20).

Besides these designs, a number of other issues must be considered by the agency in developing their strategy for reporting performance results. One of these is the media the results will be reported in. For example, states can choose to produce a hard-copy and/or web-based performance report. Web-based performance reports may also be designed to be interactive, which can provide more detailed and customizable performance information. The third consideration is the frequency with which the information is released. States report results in many different frequencies. For instance, Oregon DOT produces their performance report annually, Virginia DOT updates its web-based dashboard daily, and Washington DOT reports performance quarterly in its Gray Notebook (32).

Cambridge Systematics Inc. points out that no matter the design, the reports developed by an agency should not just present the numbers. The most effective design should include an explanation of the influences on each of the performance measures that are outside of the agency's control. Washington State includes such explanations in its Gray Notebook (24). In addition to the explanation of external factors, agencies should also report the details that go into the calculation of each of the performance measures. Doing this eliminates any confusion, in that it allows the users of the information to understand what data is used in the calculations and how the measure is calculated from the data. The Oregon Department of Transportation (ODOT) documents their

performance measures and uses a standard template to do so. Table 6 shows an example of the template used: including the name and a brief description of the measure, the division that manages the measure, how the measure is used, how it is derived, the data used to calculate the measure, and the level the measure is aggregated to (24).

Table 6: Example Performance Measure Template from ODOT (24)

Measure	State Highway System Crash Rate
Definition	Number of total crashes and fatalities per 100 million VMT and 1,000 population
Owner	Traffic Engineering Services Unit
Use	• Tracking crashes by severity and type on the state system allows the Oregon DOT to better gauge the success of engineering strategies geared toward specific types of crashes (e.g., runoff the road crashes). • The measure is a lagging indicator of safety performance. • The measure is reported annually.
Derivation	1. Identify the number of crashes by severity (fatalities, injuries, property damage) on state highways. 2. Identify the number of vehicle miles traveled on state highways and the number of people in the state. 3. Divide the number of crashes by vehicle miles traveled in millions.
Data Sources	• **Number of Crashes**—Statewide crash database. • **Number of Fatalities**—Fatality Analysis Reporting System (FARS). • **Vehicle Miles Traveled**—Oregon mileage report. • **Population**—To be determined.
Aggregation	By region and functional class (functional class aggregation will use VMT base only, not population).

2.2.5 International Perspective

In 2010, a research team put together by the FHWA from the United States performed a scan of the practices of transportation agencies abroad (Australia, Great Britain, New Zealand, and Sweden) with regard to performance-based planning programs (33). The team found that the agencies they visited were able to create a direct link between the public's needs and the agencies' goals. The agencies accomplished this by

having a clear set of nationally determined transportation goals, clearly translating these goals into concrete performance measure, frequently reporting progress towards attaining goals, and continually fine-tuning their performance measurement process over an extended period. The team also found that the agencies were able to "maximize resources, optimize assets, and earn credibility from legislators and budgeting agencies" (33 p. 2). However, despite these benefits afforded by the performance measurement process, the team also found that the information gained from the performance measurement process rarely guided resource allocation. The international practitioners interviewed pointed to the fact that transportation funding competes with other public services, like health care and education, in the appropriations process as a reason why the performance results were not directly linked to budget decisions. The practitioners also noted their frustrations with not being able to persuade legislators to increase funding with the justifications provided by the performance data. The research team also discovered the robust and highly detailed performance data that was made available in these foreign countries. In many cases, the performance information provided to the public and decision-makers was professionally produced with high quality paper and color graphics. This created much more transparency and accountability in these transportation agencies and demonstrated the agencies' commitment to performance-based planning. The foreign transportation agencies also showed a greater receptiveness to increasingly important social issues like environmental stewardship and smart growth initiatives; however, they had trouble in developing measures to account for some impacts of the transportation improvements in the areas of economic and environmental impacts.

An important lesson learned by the research team was to create a performance measurement system to reward long-term advancement over short-term results. Issues that practitioners attempt to address in transportation, like congestion and increasing densities, are long-range goals, and the measurement of an agency's performance should be long-range in nature as well. Additionally, these transportation issues are often influenced by external factors that can create fluctuations in short-term measurements that are not representative of an agency's activities. Strategies identified by the research team that can be used in creating a performance-based planning process that rewards long-term advancement over short-term results included (1) qualitative assessments to supplement the quantitative measures and (2) a focus on analyzing long-term trends with an emphasis on constant, incremental improvement.

The international scan also found that these agencies were extensively relying on a concept they call "value for money", which is essentially economic reductionism and benefit-cost analysis. The agencies use this technique to explain project and program benefits to the public and to decision-makers and, in some cases, the agencies had robust manuals for performing such analyses (33).

2.2.6 Practice in State DOTs

The state of the practice at state DOTs in performance-based planning varies widely. Larson developed a classification system that distinguished three stages in the development of a performance-based planning process at state DOTs (31). The first stage involves the development and tracking of performance measures. The approach is typically past oriented and reported in annual reports. The second stage involves measures that are aligned with the agency mission, goals, and objectives. Agencies in this

stage are beginning to set targets for the performance measures and use them in project evaluations. The third stage is distinguished by its future oriented approach to performance measurement. Agencies in this stage begin modeling performance of multiple scenarios and optimize outcomes of investment decisions

Despite the varying practices and levels of progression in performance-based planning at state DOTs, many studies have found that most state DOTs use a similar set of performance measures. The most advanced and standardized performance measurement practices at state DOTs occur in the areas of system preservation and safety. For example, most DOTs track fatalities per vehicle mile of travel (per VMT) as a measure of safety. In other areas, like economic development, congestion management, environmental stewardship, and operations, performance measurement practices are not nearly as advanced. States have made some progress in developing measures for each of these areas in the last several years; however, there is very little uniformity among the measures used (32).

2.2.6.1 Performance Measure Libraries

In an effort to create more uniformity in the performance measures used by state DOTs, Cambridge Systematics Inc., in NCHRP Report 446, created a performance measures library with an extensive list of existing performance measures. These measures were broken up into categories that are consistent with the categories of goals discussed earlier. The library includes measures that incorporate non-highway modes of travel and some measures that are viewed as being mode-neutral (18).

NCHRP Project No. 20-24(20) had a similar approach, but focused on strategic performance measurement. The report includes a compendium of strategic performance

measures from a select group of states. The report organizes the measures into some broad goal categories, like mobility and congestion, and safety, among others (20).

2.2.7 Future Challenges

Despite the progress made by the transportation industry in performance-based planning and the extensive literature on the subject, there are still a number of issues that need to be addressed. Among the most notable needs for performance-based planning is the development of a common terminology to be used as an industry standard, the development of performance measures that allow for comparison across modes, and the development of performance measures for freight transportation (21).

2.2.8 Exemplary State DOTs

One of the aims of the literature review was to identify a set of states that have made progress in implementing performance-based, and, ideally, multimodal planning processes. The idea is to use the experiences of agencies with more advanced performance-based planning processes to improve the practices of less experienced state DOTs (32). The literature identified Minnesota and Florida as two of the earliest adopters of a performance-based planning process, particularly in their statewide transportation plans. Other leading DOTs that were identified as early leaders in performance measurement include Arizona, California, Kentucky, Maryland, Missouri, Montana, Oregon, Ohio, Pennsylvania, Tennessee, Virginia, and Washington State. (11) (24).

2.2.9 Evaluation Criteria

Based on the above review of the literature regarding multimodal planning and strategic performance measurement, guidance for developing a strategic performance measurement program that incorporates multimodal planning was extracted. Reinforced

by the results of the nationwide survey of state DOTs reported in Chapter 4 below, this list serves as a framework for evaluating the success of a state DOT in developing a multimodal strategic performance measurement program, and it is applied to the five case studies reported in Chapter 5 of this thesis. The criteria that will be used in the evaluation are as follows:

- **Strategically Aligned**. Performance measures should flow directly out of an agency's mission and objectives.
- **Balanced**. Performance measures should provide a balanced picture of an agency's activities and utilize input, output, and outcome measures.
- **Manageable**. An effective performance measurement system will have a few, well-defined measures tied to a handful of clear goals (34). This is particularly true of a strategic performance measurement system. There is no exact number that is appropriate for all agencies; Florida and Pennsylvania have 15 to 20 strategic performance measures and Maryland and New Mexico each have about 80 (20).
- **Calculable.** Performance measures should use reliable and available data that the agency can collect without straining its resources (34). The measures should be capable of being measured, of being measured over time, and of being forecasted (35).
- **Readily Communicable.** Performance measurement reporting and communication should be clear and easy for decision makers and the public to understand (34).
- **Multimodal.** Both mode-neutral and mode-specific performance measures should be tracked to gauge the total effects on the system and the specific deficiencies in individual modes (36).

CHAPTER 3

NATIONWIDE SURVEY OF MULTIMODAL PRACTICES

A survey of multimodal practices at state DOTs and other select transportation agencies was conducted as part of a research project for the Georgia Department of Transportation (GDOT) (37). This chapter describes the methodology used for developing and distributing the survey and discusses the results of the survey with a particular emphasis placed on questions regarding performance measurement. In doing so, the survey results were used in this thesis to gauge the current practices of state DOTs in multimodal performance measurement and to further inform the selection of a set of state DOTs to perform case studies on.

3.1 Survey Methodology

The survey was developed using *SurveyMonkey.com*, a web-based survey tool that makes the survey accessible through a designated on-line link. The survey link, along with a brief description of the research project, was sent to the directors or primary contacts of the divisions or planning offices at the 50 state DOTs that have responsibility for statewide multimodal planning. The survey was also sent to directors or primary contacts at state aeronautical commissions, at the request of the GDOT Intermodal Division. For consistency purposes, only the responses of the state DOTs will be discussed in this thesis.

The survey contained 19 questions which inquired about modal responsibility, statewide plans, funding structure, cross-modal comparisons and the use of performance measures to support such comparisons, barriers to and needs for multimodal planning, staff support, and progress made in the field of multimodal planning. The questions posed

in the survey were designed in a number of formats, including multiple choice questions, rating scale questions (five-point Likert scale), matrix questions, and open-ended questions. A copy of the entire survey can be found in Appendix A.

From April 27, 2012 to August 31, 2012, 40 responses were received with 35 coming from state DOTs (a response rate of 70%). Figure 3 is a map of the U.S. depicting the states from which a response was received. The shaded states denote the state DOTs that responded to the survey.

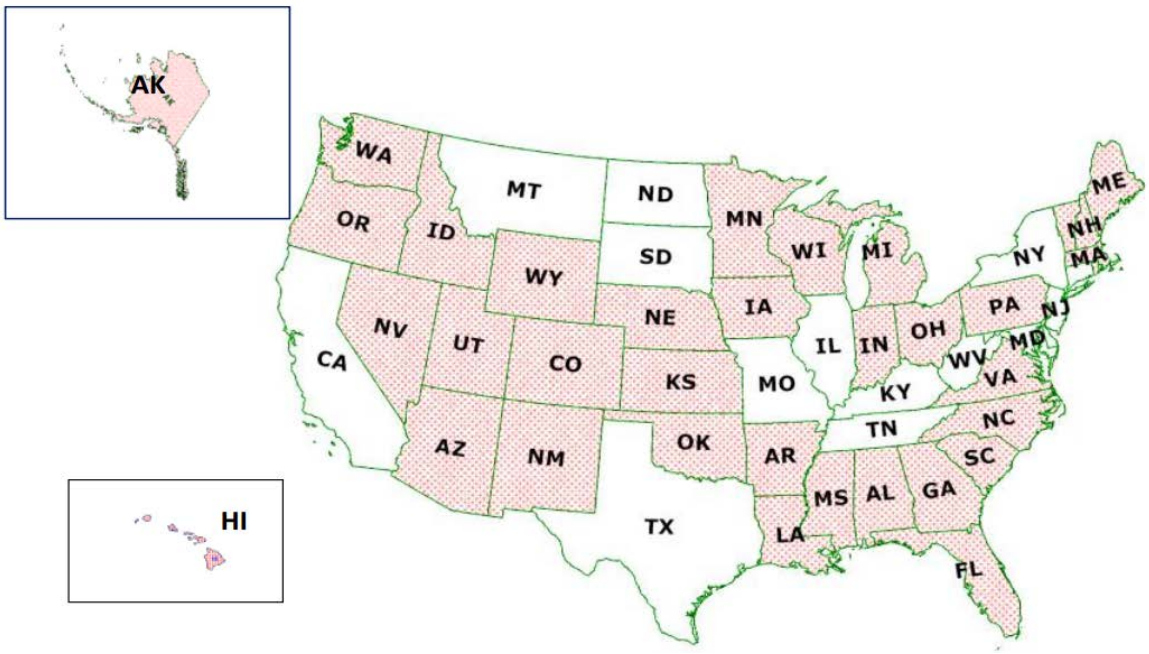


Figure 3: States Responding to the Nationwide Survey of Multimodal Practices

3.2 Survey Results

The results of the questions relating to multimodal planning and the use of performance measures in cross-modal comparisons will be presented in this section. After the first three questions for respondent identification, the first substantial question of the survey was designed to determine what modes of transportation state DOTs typically held responsibility for other than highways. The question was posed as:

Q4. If you work in a state DOT, which of the following modes of transportation does your state DOT have some responsibility for? Please indicate who is responsible for each mode so indicated. (Note all that apply)

As this survey was distributed to agencies other than state DOTs, the question filtered out responses from other agencies by only asking for responses from DOT respondents. The question also asked the respondents to indicate what department was responsible for the particular mode and respondents were able to select more than one option per mode. The choices for the responsible department included planning, intermodal bureau or division, mode-specific bureau or division, special unit within the Secretary's/Director's Office, or other. For the purposes of this thesis, however, the department responsible is not of significant importance, and the results were analyzed based on whether any department in the agency had responsibility or not. 34 state DOTs replied to this particular question.

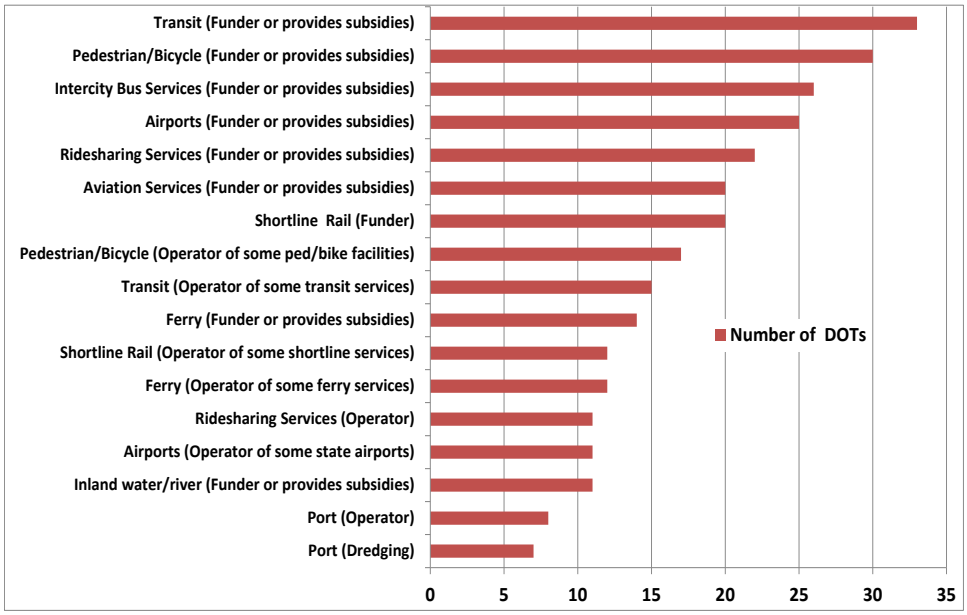


Figure 4: Responses to Question 4 of the Nationwide Survey

Figure 4 shows the responses to the question regarding modal responsibility at state DOTS. The left side of the graph contains the list of modes and types of activities for the modes while the right side contains bars that depict the number of DOT respondents that claim responsibility for the corresponding mode and activity. What the results show is that state DOTs funded or provided subsidies for non-highway modes much more frequently than they operated such facilities. The modes of transportation that were most frequently funded by state DOTs include transit, pedestrian/bicycle facilities, intercity bus service, airports, and ride sharing services. Ferries, inland water ways, and ports were funded with the least frequency by state DOTs. After determining what modes generally fall under the purview of state DOTs, the survey respondents were then asked three questions about the extent to which modal strategies were considered and compared in the transportation planning process. The first question was posed as:

Q6. In your opinion, to what extent does your agency conduct multimodal transportation planning that examines different modal strategies among the state-responsible modes indicated in Q4 above?

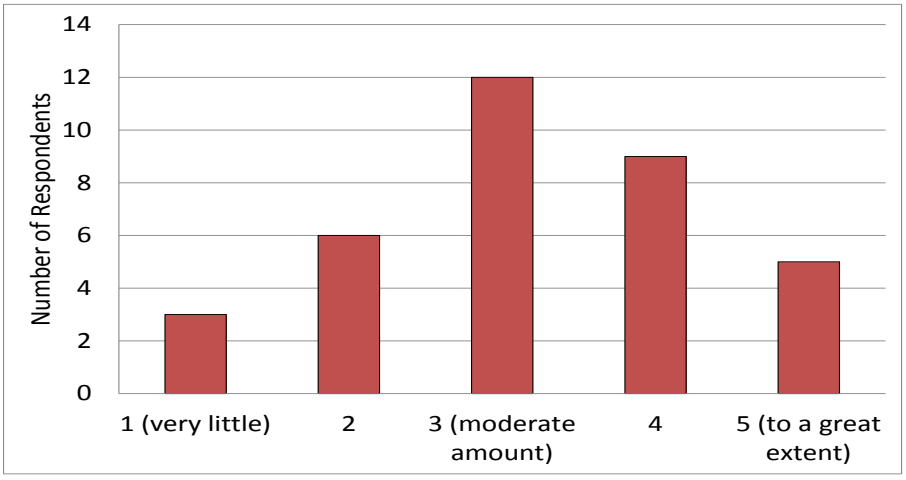


Figure 5: Responses to Question 6 of the Nationwide Survey

Respondents were required to quantify their answer on a scale of 1 to 5, with 1 being very little, 3 being a moderate amount, and 5 being to a great extent. Figure 5 displays a histogram of the responses to the question regarding the examination of different modal strategies. All 35 of respondents from state DOTs responded to this question. The results showed that 26% of respondents (9 respondents) examined different modal strategies to a less than moderate extent, 34% (12 respondents) examined different modal strategies to a moderate extent, and 40% (14 respondents) examined modal strategies to a greater than moderate extent in the planning process. The next question in the survey gauged the extent to which state DOTs actually compared the different modal options to one another. This question was communicated as:

Q7. To what extent are different modal options compared to one another in the planning/programming process to determine the most cost effective investment for the state?

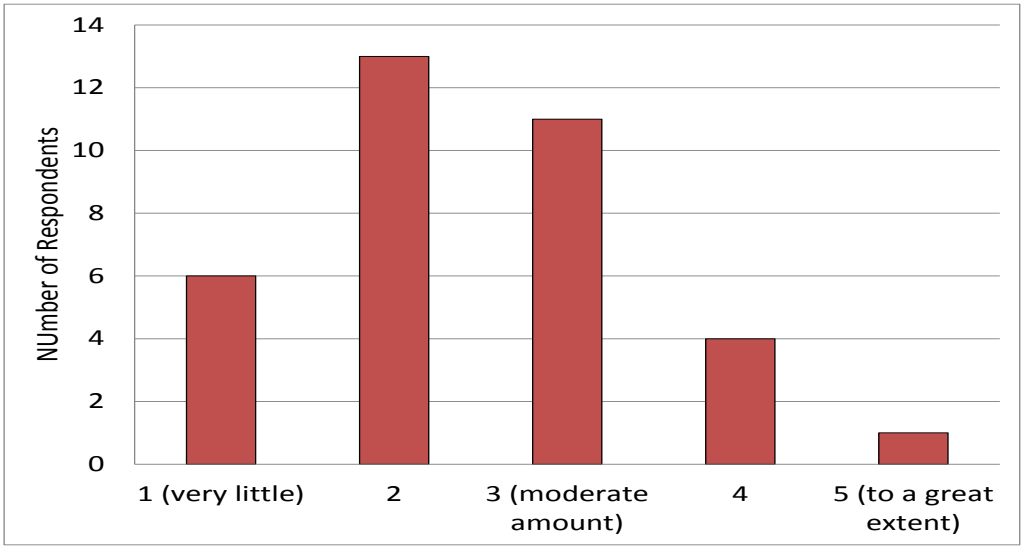


Figure 6: Responses to Question 7 of the Nationwide Survey

Once again, the respondents were required to quantify their answer on a scale of 1 to 5. Figure 6 shows the results collected from this question relating to the comparison of modal alternatives. All 35 respondents from state DOTs responded to this question. The results showed that 54% of respondents (19 respondents) compared different modal options in the planning and programming process to a less than moderate extent, 31% (11 respondents) compared modal options to a moderate extent, and 15% (5 respondents) compared options to a greater than moderate extent. Following this, respondents were then asked about specific measures used in comparisons. The question was presented as:

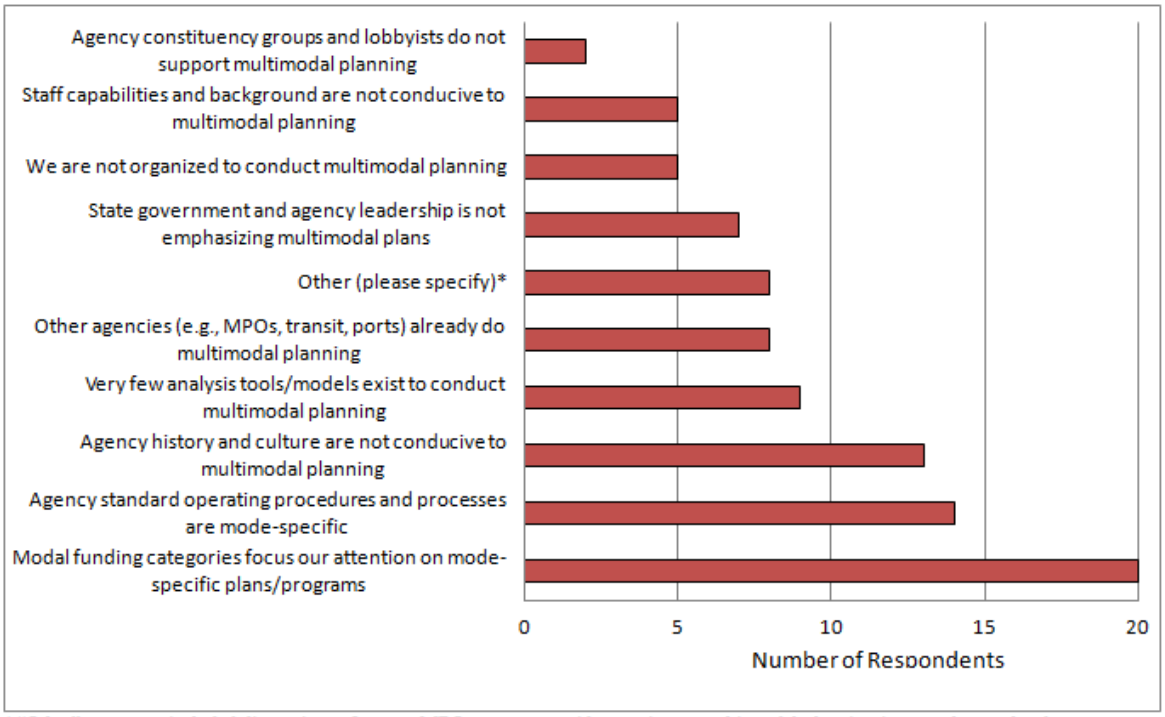
Q8. If different modal options are compared to one another, are there specific evaluation criteria that are used to conduct such a comparison?

In total, 34 respondents from state DOTs replied to this question. The results from this question showed that 56% of the respondents (19 respondents) stated that no evaluation criteria were used in cross-modal comparisons, 24 % (8 respondents) responded either that they did not know or that the question was not applicable, and only 21% (7 respondents) stated that specific evaluation criteria were used in the comparison of different modal strategies.

The next two questions asked the respondents for their opinion on barriers to their agency conducting multimodal planning and the characteristics of a truly multimodal agency. The first question, which gauged what the perceived barriers to multimodal planning were, was worded in the following manner:

Q13. Given your experience with multimodal transportation planning, identify three of the most important reasons that can explain why such planning has not been undertaken more fully in your agency.

Respondents were allowed to select up to three answers from a list of ten possible answers (which included an option for "other"). Figure 7 shows the results of this question. The possible answers are listed along the left and the number of respondents selecting each answer is portrayed by the corresponding bars on the right. From the responses, it became clear that the most frequently perceived barriers included modal funding that focuses agency attention on mode-specific plans or programs, standard operating procedures that are mode-specific, agency history and culture, and a lack of analysis tools that allow for multimodal planning.



* "Other" responses included discussions of greater MPO versus statewide attention to multi-modal planning in sparsely populated states.

Figure 7: Responses to Question 13 of the Nationwide Survey

The final question that will be examined from the survey centers around what characteristics practitioners believe an agency must have to be truly multimodal. The question respondents were asked was:

Q17. **What are the characteristics that are necessary in a state DOT to be considered a multimodal agency?**

This question was designed to allow for an open ended response. In order to facilitate analysis, the responses were then classified into a number of categories of characteristics necessary for an agency to be considered multimodal. In addition, as this question was open ended, some respondents included multiple characteristics, so while only 30 respondents from state DOTs replied to this question, there are actually 38 total characteristics identified in the responses. Figure 8 shows the responses to Question #17 with the categorized characteristics listed on the left and the corresponding number of responses visualized through bars on the right.

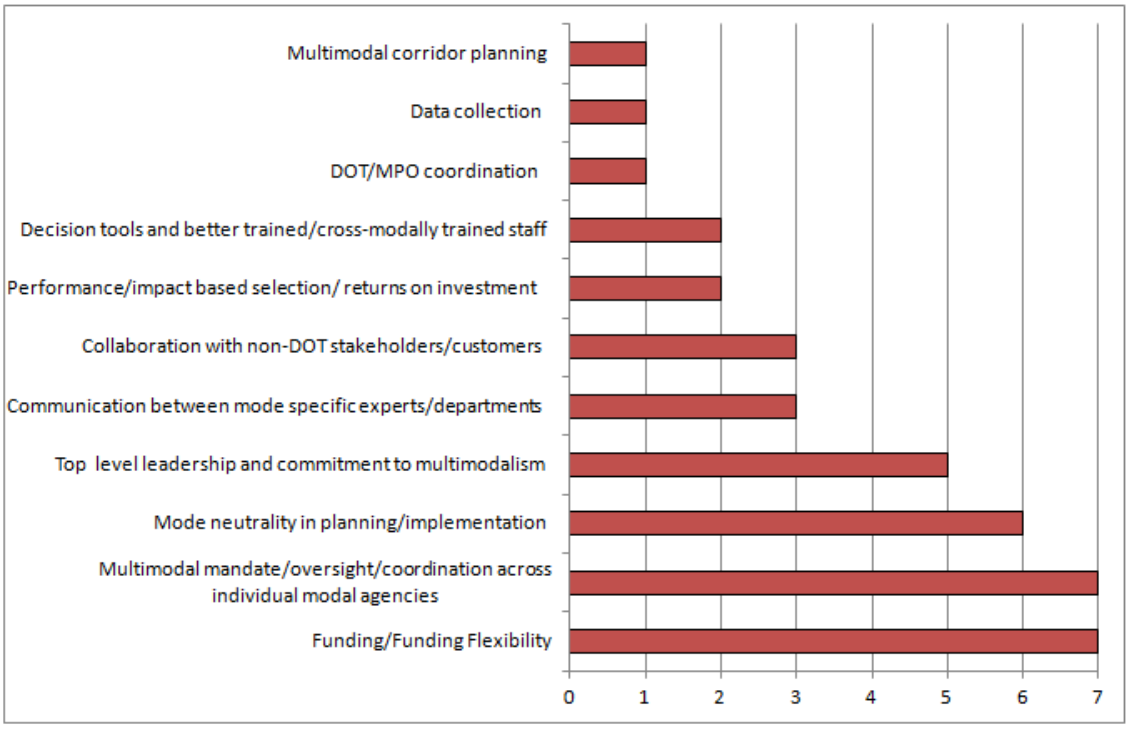


Figure 8: Responses to Question 17 of the Nationwide Survey

The most frequently cited characteristics of a multimodal agency include funding flexibility, interaction between separate modal agencies, mode-neutrality in planning and

implementation, and top level leadership and commitment to multimodal planning. Performance-based planning was also identified by two agencies as characteristic of a multimodal agency.

3.3 Discussion

The results of the survey show that while, on average, state DOTs examine different modal options at a moderate-to-great extent, they only compare these different modal options in the planning and programming processes at a very little- to-moderate extent. The respondents from state DOTs also revealed that when different modal options are compared, a specific set of evaluation criteria or measures are rarely used to facilitate the comparison. This shows that there is a need at state DOTs for improved performance-based planning that allows the comparisons of different modal options.

The next question examined from the survey, regarding barriers to multimodal planning, shows that performance-based planning could be a useful tool in transitioning an agency from a traditional, highway-centric DOT to a truly multimodal DOT. The most frequently cited barriers to performing multimodal planning at state DOTs included modal funding that focuses agency attention on mode-specific plans or programs, standard operating procedures that are mode-specific, agency history and culture, and a lack of analysis tools that allow for multimodal planning. Performance-based planning could be a useful medium for addressing each of these barriers. The outputs of a performance-based planning process can provide justification for relaxing modal funding restrictions. The incorporation of a multimodal performance-based planning process inherently changes the standard operating procedures of an agency. The use of performance-based planning has been shown in the literature to be an effective tool for

changing an agency's culture. Finally, the focus on multimodal performance-based planning will place a greater emphasis on the development of analytical tools that can facilitate cross-modal comparisons.

The question relating to the characteristics of a multimodal agency also shows the importance of performance-based planning to the success of a multimodal agency. One of the top characteristics identified as a must for truly multimodal agencies was a mode-neutral approach to planning, something made possible by incorporating a performance-based approach to planning. Other characteristics that were identified and implied the need for performance-based planning at multimodal agencies included performance-based selections, decision tools and cross-modally trained staff, and data collection programs.

CHAPTER 4

CASE STUDIES

The results of the Chapter 2 literature review and Chapter 3 nationwide survey were supplemented with discussions with industry leaders in identifying a set of innovative state DOTs to perform in-depth case studies on. This led to the selection of a set of case studies that focus on the success of five different state DOTs in developing and applying multimodal, strategic performance measures. The five states examined are Florida, North Carolina, Maryland, Minnesota, and Washington, and the principal resources used to evaluate the performance management programs at each DOT are the strategic plans, LRSTPs, STIPs, and other performance measurement documents posted on the state DOT's website or collected from state officials. It is necessary to point out that not all of a state DOTs multimodal and performance based planning activities are necessarily captured in the documents available for review, and that on-going efforts may include additional activities not captured in the description below. However, it is believed that the documents reviewed in this chapter provide a good deal of insight into the current state of practice and recent progress being made in multimodal performance measurement within these DOTs.

The list of criteria developed in the literature review serves as the framework for organizing each case study and evaluating each of the state DOTs, i.e. (cf. section 2.2.9):

- **Strategically Aligned**. Performance measures should flow directly out of an agency's mission and objectives.
- **Balanced**. Performance measures should provide a balanced picture of an agency's activities and utilize input, output, and outcome measures.

- **Manageable**. An effective performance measurement system will have a few, well-defined measures tied to a handful of clear goals (34).
- **Calculable.** Performance measures should use reliable and available data that the agency can collect without straining its resources (34). The measures should be capable of being measured, of being measured over time, and of being forecast (35).
- **Readily Communicable.** Performance measurement reporting and communication should be clear and easy for decision makers and the public to understand (34).
- **Multimodal.** Both mode-neutral and mode-specific performance measures should be tracked to gauge the total effects on the system and the specific deficiencies in individual modes (36).

The sections analyzing the strategic alignment of performance measurement programs identify the goals, objectives, and sets of performance measures used by the state DOTs, and discuss the statewide planning and performance measurement documents these goals, objectives, and performance measures are included in. The sections examining the balance of the performance measurement programs attempt to identify the inclusion of input, output, and outcome measures in the programs at each of the state DOTs. The analysis reported does not attempt to classify specific measures because the application of the definitions identified in the literature for output and outcome measures can be subjective. For instance, the measure of public transit ridership is a difficult measure to classify. An argument can be made that public transit ridership is the outcome measure to the output measure of average bus frequency. It could also be argued that the public transit ridership is the output measure and the outcome measure is the obesity rate or the travel time reliability in urban areas or the transportation-related

greenhouse gas emissions reduced by such riders leaving their automobiles at home. Due to the ambiguity that results from applying these definitions to specific measures, the analysis will focus on examining the balance of the performance measurement programs at the set level and on highlighting obvious and objective innovations in balancing the use of input, output, and outcome measures at the state DOTs. The sections discussing the manageability of the performance measurement programs focuses on the number of sets of performance measures at each agency and the number of measures within each of the sets of performance measures. The number of sets and measures within sets focuses on the agency's ability to track the measures as well as the ability of the different audiences to comprehend the measures. The calculability sections examine three characteristics of the performance measurement programs: the ability of the agency to calculate measures, the ability of the agency to calculate the measures in a repeatable manner, and the ability of the agency to forecast future performance under various funding scenarios. The communication sections discuss the performance reporting media used by the state DOTs. The discussion here centers around the types of performance reporting media (dashboard, scorecard, report), the graphics used to relay performance information, the design of performance reporting media, the intended audience, and the frequency of updates to the reporting media. Finally, the multimodal sections examine the inclusion of mode neutral performance measures and mode-specific measures in the performance measurement programs at the state DOTs. In addition, where applicable, agency efforts in conducting multimodal tradeoff analysis are discussed in the multimodal sections.

4.1 Florida Department of Transportation

The analysis of FDOT's performance measurement program will cover each of the six evaluation criteria identified in the literature review. The analysis will be based on the department's publicly available statewide planning and performance measurement resources. Included in these resources are the Florida Transportation Plan, the 2012 Performance Report, the Strategic Intermodal System (SIS) Strategic Plan, the full set of At-A-Glance summaries, the document titled Performance Briefs: SIS Performance, and the Performance Dashboard.

In order to provide the proper background information for FDOT's performance measurement program, it is important to highlight the state's Strategic Intermodal System (SIS). The SIS is a designated network, based on quantitative criteria, of the state's most significant transportation facilities of all modes. The 2020 Florida Transportation Plan pushed for the creation of the SIS in 2000, and by 2003, legislation had been passed that codified the SIS into law (38). Today, the transportation facilities included in the SIS account for 99 percent of commercial air passengers and cargo, nearly all waterborne and rail freight, 89 percent of rail and bus passengers, 55 percent of all traffic, and 70 percent of all truck traffic on the State Highway System (38). Facilities that are designated as SIS facilities can be funded with statewide managed SIS funds and have a greater chance of obtaining other funds from local, federal, and private sector sources (38). In fact, in 2011, SIS facilities received 44 percent of FDOT spending (39). Seeing the importance of this designated network, the FDOT Systems Planning Office develops a separate set of planning documents for SIS facilities (40). The performance measurement program also uses a separate set of documents for the SIS, as discussed below.

4.1.1 Strategically Aligned

The state's LRSTP, the Florida Transportation Plan (FTP), is a key component of the department's performance measurement program. The document, which is updated every five years, describes the state's transportation vision for the future and establishes the goals, objectives, and strategies for achieving the vision. The most current version, the 2060 FTP, defines six goal areas and the document is organized around these six goal areas. The goal areas identified in the plan include economic competitiveness, community livability, environmental stewardship, safety and security, maintenance and operations, and mobility and connectivity. For each of these goal areas a set of objectives, implementation strategies, and potential indicators is identified (41).

Table 7 contains the goals and corresponding objectives outlined in the FTP. The left column lists the agencies goal areas and the right column identifies the objectives that correspond to each of the goal areas in the left column. The FTP does not concretely identify a set of performance measures, but calls on transportation partners to establish measurable short range objectives, develop and use consistent performance measures based on the goals and objectives identified in the FTP, and report the performance information to demonstrate progress in meeting the FTP goals (41).

Table 7: 2060 FTP Goals and Objectives

Goals	Objectives
Economic Competitiveness	Maximize Florida's position as a strategic hub for international and domestic trade, visitors, and investment by developing, enhancing, and funding Florida's SIS.
	Improve transportation connectivity for people and freight to established and emerging regional employment centers in rural and urban areas.
	Plan and develop transportation systems to provide adequate connectivity to economically productive rural lands.
	Invest in transportation capacity improvements to meet future demand for moving people and freight.
	Be a worldwide leader in development and implementation of innovative transportation technologies and systems.
Community Livability	Develop transportation plans and make investments to support the goals of the FTP and other statewide plans, as well as regional and community visions and plans.
	Coordinate transportation investments with other public and private decisions to foster livable communities.
	Coordinate transportation and land use decisions to support livable rural and urban communities.
Environmental Stewardship	Plan and develop transportation systems and facilities in a manner which protects and, where feasible, restores the function and character of the natural environment and avoids or minimizes adverse environmental impacts.
	Plan and develop transportation systems to reduce energy consumption, improve air quality, and reduce greenhouse gas emissions.
Safety and Security	Eliminate fatalities and minimize injuries on the transportation system.
	Improve the security of Florida's transportation system.
	Improve Florida's ability to use the transportation system to respond to emergencies and security risks.
Maintenance and Operations	Achieve and maintain a state of good repair for transportation assets for all modes.
	Reduce the vulnerability and increase the resilience of critical infrastructure to the impacts of climate trends and events.
	Minimize damage to infrastructure from transportation vehicles.
	Optimize the efficiency of the transportation system for all modes.
Mobility and Connectivity	Expand transportation options for residents, visitors, and businesses.
	Reinforce and transform Florida's Strategic Intermodal System facilities to provide multimodal options for moving people and freight.
	Develop and operate a statewide high speed and intercity passenger rail system connecting all regions of the state and linking to public transportation systems in rural and urban areas.
	Expand and integrate regional public transit systems in Florida's urban areas.
	Increase the efficiency and reliability of travel for people and freight.
	Integrate modal infrastructure, technologies, and payment systems to provide seamless connectivity for passenger and freight trips from origin to destination.

Where the Florida Transportation Plan has left off, other FDOT documents have picked up from with regard to the development of performance measures. There appear to be three distinct sets of performance measures in use at FDOT at the strategic level. This thesis will refer to these sets of measures as the agency-wide performance measures, the SIS performance measures, and the dashboard performance measures. .

4.1.1.1 Agency-Wide Performance Measures

The 2012 Performance Report combines some of the goals areas established in the FTP, which reduces the total number of goal areas to four. The names of the newly organized goal areas in the 2012 Performance Report are "Safety and Security", "Maintenance and Operations", "Economic Competitiveness and Mobility" (combination of "Economic Competitiveness" and "Mobility and Connectivity"), and "Quality of Life and Environmental Stewardship" (combination of "Community Livability" and "Environmental Stewardship") (42). The performance report also establishes more measurable or "operational" short-range objectives and presents the performance measures that relate to each of the objectives (42). Table 8 shows the revised goal areas with the corresponding objectives and performance measures that are identified in the 2012 Performance Report. The first column lists the combined goal areas, the second column lists the short-range objectives, and the last column identifies the corresponding performance measures for each of the short-range objectives. While some measures of performance were briefly referenced in the text of the report, only the performance measures reported in the document in the form of a graphic are included in this table and examined throughout this case study.

Table 8: Goals, Objectives, and Performance Measures in FDOT's Agency-Wide Set of Measures

Goals	Objectives	Performance Measures
Safety and Security	Reduce by 5 percent annually the number of highway fatalities and serious injuries	• Total serious injuries and fatalities due to crashes • Fatality rate on public roads (per 100M VMT) • Serious injuries and fatalities attributed to aggressive driving • Intersection crash serious injuries and fatalities • Bicycle serious injuries and fatalities • Pedestrian serious injuries and fatalities • Motorcyclist serious injuries and fatalities • Lane-departure serious injuries and fatalities • Crashes involving driver impairment by alcohol and drugs • Aging driver (65+) serious injuries and fatalities • Teenage driver (15-19) serious injuries and fatalities • Incidents, fatalities, injuries, and property damage for top ten transit agencies by mode • Fixed route transit incidents
	Update emergency response plans and readiness procedures for disaster response and conduct regular training exercises	No measure specified
Maintenance and Operations	Ensure that 80 percent of pavement on the State Highway System meets Department Standards	• Percent of pavement meeting standard
	Ensure that 90 percent of Department-maintained bridges meet standards while keeping all Department-maintained bridges open to the public safe	• Percent of bridges meeting structural standard
	Achieve 100 percent of the acceptable maintenance on the State Highway System	• Percent of maintenance meeting standard
	Improve system efficiency by deploying ITS technology on critical state corridors	• Commercial motor vehicle crash rate • FDOT managed ITS miles
Economic Competitiveness and Mobility	Make strategic investments that support statewide and inter-regional mobility	• Benefit-cost ratio of investments
	Allocate up to 75 percent of new discretionary capacity funds to the SIS	• Capacity funds for SIS and non-SIS projects
	Maintain the average growth rate in person-hours of delay on SIS highways at or below 5 percent	• Person-hours of delay compared to daily VMT, population, and lane miles

	Support efforts to enable Florida to expand its role as a hub for international and domestic trade logistics and export-oriented manufacturing	No measure specified
	Maximize the use of existing facilities	No measure specified
	Develop/redevelop multi-modal corridors to support future mobility	No measure specified
	Participate in statewide and regional visioning efforts	No measure specified
	Increase transit ridership at twice the average rate of population growth	• Fixed route passenger trips and revenue miles • Number of one-way transit trips and one-way transportation disadvantaged (TD) trips • Operating cost per passenger trip and TD trip • Annual percentage change of transit ridership and annual percentage change of population
Quality of Life and Environmental Stewardship	Make transportation decisions in the context of community interests, plans, values and visions	No measure specified
	Enhance the Florida travel experience	No measure specified
	Deliver a transportation system that supports quality of life and environmental stewardship	No measure specified

4.1.1.2 SIS Performance Measures

The Strategic Intermodal System Strategic Plan (SIS Strategic Plan) and the accompanying Performance Briefs: SIS Performance (SIS Performance Brief) use the goals defined in the FTP to establish objectives and performance measures specific to the SIS. The SIS Strategic Plan, references both the long-range goals and long-range objectives from the FTP, and uses these to develop short-range objectives specifically for the SIS; however, these short-range objectives are not explicitly linked to the goal areas identified in the FTP. The result is a set of seven short-range objectives without defined goal areas to which they belong (38). These short-term objectives are then used in the SIS Performance Brief to develop and organize a set of performance measures specific to the SIS (43). The short-term objectives and accompanying performance measures found in

the SIS Strategic Plan and the SIS Performance Brief are summarized in Table 9. The left column lists the seven short-range objectives and the right column identifies the corresponding performance measures. Once again, only the performance measures explicitly identified with graphics are accounted for in this case study.

Table 9: Objectives and Performance Measures in FDOT's SIS Set of Measures

Objectives	Performance Measures
Enhance connectivity between Florida's economic regions and between Florida and other states and nations for both people and freight	• Pavement ratings • Bridge ratings • Maintenance ratings
Reduce delay on and improve the reliability of travel and transport using SIS facilities	• Percent of travel congested at peak-hour • Percent of centerline miles congested at peak-hour
	• Person-hours of delay compared to daily VMT, population, and lane miles
	• Flight arrival on-time performance at SIS airports (% on-time, % delayed, % canceled)
	• Flight departure on-time performance at SIS airports (% on-time, % delayed, % canceled)
Expand modal alternatives to SIS highways for travel and transport between regions, states, and nations	• Growth trends of person-travel by mode (transit boardings, Amtrak, vehicle miles, airline, cruise activity)
Provide for safe and efficient transfers for both people and freight between all transportation modes	No measure specified
Provide transportation systems to support statewide goals related to economic diversification and development	• Florida international trade (value of imports and exports)
Reduce growth rate in vehicle-miles traveled and associated energy consumption and emissions of air pollutants and greenhouse gases	• Florida energy consumption by sector (BTUs)
	• Transportation gross GHG emissions by fuel (MMT C02 e)
Help ensure Florida's transportation system can meet national defense and emergency response and evacuation needs.	• Number of commercial motor vehicle safety inspections performed

4.1.1.3 Dashboard Performance Measures

FDOT also uses a unique set of performance measures for their performance dashboard; however, these measures do not appear to be explicitly derived from the FTP goal areas. The performance dashboard is organized around five sections: safety, project

delivery, maintenance, mobility, and accountability. Three of these sections (safety, maintenance, and mobility) appear to align directly with the goal areas defined in the FTP, but two of the sections (project delivery and accountability) are not designated as goals in the FTP. There are no objectives stated for each of these sections; however, each section does have a set of aligned performance measures. Each of the measures also has a specified performance target, which is referred to as an "objective" in the dashboard (44). It is important to note that this use of the term objective is not consistent with the terminology defined in the literature review in Chapter 2 above. What FDOT calls an "objective" in the dashboard is more of a target, according to the literature. It does bring up an interesting point, however. The targets used by FDOT and, perhaps all targets in general, can be translated into short-range objectives. For instance, the target of a 5% reduction from the previous year for total fatalities could be translated into an objective stated as "Reduce total fatalities by 5 percent annually." This really blurs the line of differentiation between targets and objectives. However, for the purposes of this thesis, the descriptions of targets and performance measures established in the literature review will be adhered to. Table 10 was created from the goal areas, performance measures, and targets presented in the performance dashboard.

Table 10: Goals, Performance Measures, and Targets in FDOT's Dashboard Set of Measures

Goals	Performance Measures	Targets
Safety	Total Fatalities	5% reduction from previous year
	Total Serious Injuries	5% reduction from previous year
	Pedestrian and Bicycle Fatalities	5% reduction from previous year
	Pedestrian and Bicycle Serious Injuries	5% reduction from previous year
	Motorcyclist Fatalities	5% reduction from previous year
	Motorcyclist Serious Injuries	5% reduction from previous year
Project Delivery	Number of Contracts	≥ 95%
	Percent of contracts on time	≥ 80%
	Percent of contracts on budget	≥ 90%
Maintenance	Maintenance Rating	≥ 80
	Pavement Condition	≥ 80%
	Bridge Condition	≥ 80%
Mobility	Percent of planned lane miles of capacity improvement projects letted	≥ 90%
	Growth rate of public transit ridership compared to population growth rate	≥ 2 times the population growth rate
	Average incident clearance time	< 90 minutes
Accountability	Administrative costs as percentage of total program	< 2%
	Percent of federal funds subject to forfeiture at end of fiscal year committed	100%

4.1.1.4 Summary

Of the three sets of performance measures used by FDOT at a strategic level, two clearly are strategically aligned. These two sets are the agency-wide performance measures and the SIS performance measures. These two sets of performance measures are intended for different purposes and thus incorporate different performance measures. While these two distinct sets of measures are different, they are both strategically aligned, in large part due to the decentralized approach that the FTP employs for the development of performance measures. The alignment of the agency-wide performance measures is apparent, from goals to objectives and objectives to performance measures. The

alignment of the SIS performance measures is a little less obvious. The relationships between the short-range objectives and the goals were not clearly identified; however, the SIS Strategic Plan clearly states that the short-range objectives were developed in alignment with the agency's goals. These short-range objectives are clearly linked to the performance measures; therefore, this set of measures is also strategically aligned.

The third set of performance measures, the dashboard performance measures, do not appear to be strategically aligned with the FTP because the goal areas used on the dashboard are different from the goal areas identified in the FTP. This may be because the goal areas identified in the FTP do not include any mention of organizational performance or accountability, issues that are important to the public but are not particularly important to the selection and prioritization of transportation projects. The performance dashboard, with its attractive design and easy accessibility, appears to be intended for the public and therefore needs to include information about the agency's organizational performance. In this case, it appears that FDOT consciously made the choice not to align the dashboard performance measures with the FTP in order to tailor the dashboard to meet the transparency and accountability needs of the public.

4.1.2 Balanced

FDOT does not classify any of its measures as being input, output, or outcome measures. The ambiguous nature of applying the definitions of input, output, and outcome measures to classify specific measures is difficult, therefore the balance of the performance measures will be evaluated at the set level.

The agency-wide set appears to be mostly composed of outcome measures with a few output and input measures. The safety and security measures appear to be solely

outcome measures while the goals of maintenance and operations and economic competitiveness appear to contain the only output and input measures in the set. The SIS set also appears to contain mostly outcome measures with the exceptions being a couple of output measures. The dashboard set appears to be the most balanced of the three sets of measures. While the majority of the measures used are outcome measures, there is a fair amount of output and input measures included. In this set, the goal areas used in the dashboard for project delivery and accountability solely contain output and input measures while the goal areas for safety, maintenance, and mobility are mostly composed of outcome measures. The fact that the dashboard set contains more output measures could be attributed to the purpose of the performance dashboard. As discussed earlier, FDOT appears to use the performance dashboard in relaying organizational performance to the public. Using more output measures, rather than outcome measures, would allow the agency to communicate its level of effort rather than the outcome of events that are not entirely under the agency's control.

4.1.3 Manageable

Because of FDOT's decentralized approach to performance measure development, three different sets of performance measures are used at the strategic, statewide level. While this decentralized approach allows for greater flexibility in the development of performance measures, the use of numerous sets of performance measures has the potential to become unmanageable for an agency. It seems, however, that FDOT uses these three performance measure sets for distinct purposes and the potential unmanageability is worth the ability to customize performance measures for different audiences and purposes. Within each of the performance measure sets, the number of

measures included certainly appears manageable. The agency-wide performance measure set includes 25 total performance measures. The SIS performance measure set includes 13 measures and the dashboard performance measure set includes 17 performance measures. The agency-wide set has the most measures of the three, and understandably so. The SIS performance measures are used for a subset of the state's transportation facilities so it is expected that this set of measures is smaller than the agency-wide set. The dashboard set of measures is also smaller than the agency-wide set. This is also expected because the target audience, the public, does not require or may become confused by the large amount of information needed by agency officials and planners.

4.1.4 Calculable

The three issues that must be addressed in determining how quantifiable FDOT's performance measures are: whether the measures can be calculated, whether these calculations can be reproduced, and whether the reproduction of the calculations can lead to a forecast of future performance levels. To address the first issue, FDOT is able to calculate all of the performance measures included in the tables above for all three sets of performance measures. Measures that cannot be calculated are not included in the agency's performance documents collected for this thesis. With that being said, there are goal areas in the agency-wide set of measures that have few, if any quantifiable measures. For instance, environmental stewardship and quality of life has no quantifiable measures specified and economic competitiveness and mobility have numerous objectives that do not have quantifiable performance measures. In contrast, the goal areas of safety and security and maintenance and operations each have a well composed set of measures that quantify performance.

In addition to simply being able to calculate the performance measures, another important issue for a successful performance measurement program is the repeatability of performance measure calculations. Nearly all of the performance measures used by FDOT can be repeatedly calculated. This is evidenced by the historical performance data included in the agency's performance documents that show performance trends for nearly all of the measures. Examples of the inclusion of past performance data in performance documents are included in the "communicable" section. A few measures did not include past performance data. These measures include the benefit-cost ratio of the FDOT work program and the transit safety performance measures of number of incidents, fatalities, injuries, and property damage for the top 10 agencies. The benefit-cost ratio used in the 2012 Annual Performance Report is from a macroeconomic analysis performed in 2009. It seems that this measure is costly and difficult for the agency to calculate, so the agency may only perform this calculation periodically. As for the safety performance measures for the state's top 10 transit agencies, the difficulty in coordinating data collection and reporting for 10 distinct transit agencies may be the reason for the lack of past performance data for these measures.

The final issue to be addressed is the use of past performance data to forecast future performance levels under various funding scenarios. From all of FDOT's documents relating to performance measurement, no evidence was found to suggest that FDOT actively projects future performance levels for any of the performance measures included in the three sets of strategic, statewide performance measures. However, there appears to be no reason why this could not be done for many of the measures using a suitable, possibly model-based, scenario generation process.

4.1.5 Communicable

FDOT has a number of media through which it communicates performance: At-A-Glance summaries, the Annual Performance Report, the SIS Performance Report, and the Performance Dashboard. The agency-wide performance measures are reported in the At-A-Glance summaries and the Annual Performance report. The SIS performance measures are reported in the SIS Performance Report. Finally, the dashboard performance measures are reported in the Performance Dashboard. Each of the reporting media will be examined in the following sections.

4.1.5.1 At-A-Glance Summaries

There are five At-A-Glance summaries produced by FDOT: one that summarizes the overall performance of the system in the goal categories from the agency-wide set of measures, and four more that summarize the system performance in each of the combined goal areas (42) (45). The overall At-A-Glance for all goal areas is a two page document that is printed onto a double-sided brochure, meant to be folded in half. The front cover of the brochure is a title page, the inside of the brochure contains the performance information for four goal areas (economic competitiveness, preservation, safety, and mobility), and the back cover briefly discusses the use of performance measures at the department (45). Figure 9 shows the inside of the overall At-A-Glance brochure containing the summarized performance information.

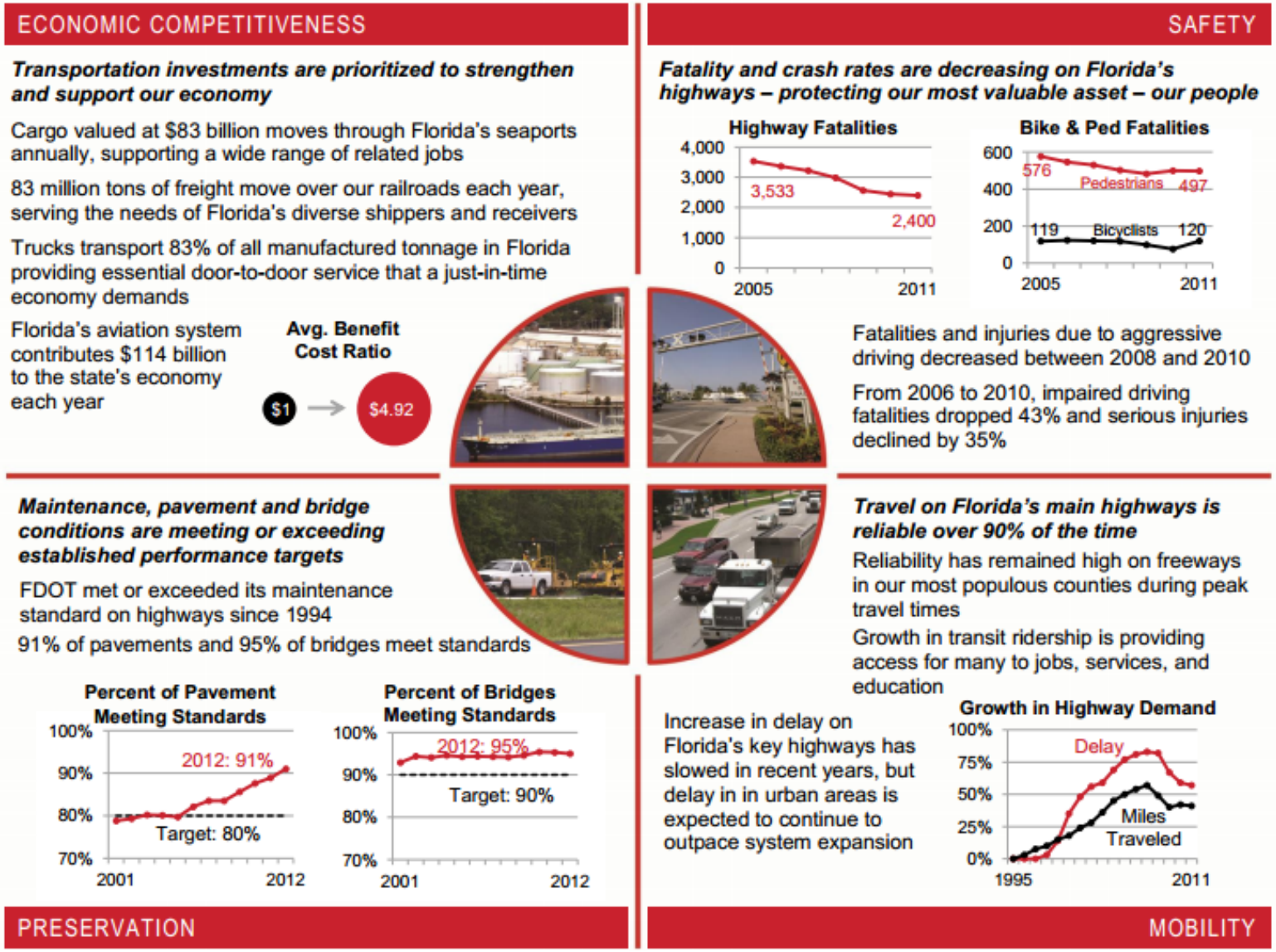


Figure 9: Inside of FDOT's Overall At-A-Glance Brochure for All Goal Areas (45)

The four goal areas examined in this summary each receive a quarter of the page, and the key performance measures in each of the goal areas are presented. The quarter for economic competitiveness discusses the characteristics of Florida's freight needs and reports the average benefit cost ratio of the department's transportation investments. The quarter representing preservation reports on the department's progress in achieving standards for pavement and bridge conditions. The section on safety presents the data relating to highway fatalities and bike and pedestrian fatalities. Finally, the section addressing mobility reported on the growth in highway demand and delay and discussed the reliability of the highways and the important role transit plays is providing accessibility for citizens. It is important to note that these four sections do not directly relate to the combined goal areas established for the agency-wide performance measures. The combined goal area of quality of life and environmental stewardship is not included in the overall At-A-Glance summary, perhaps because there are no measures identified for this goal area. In addition, the combined goal area of economic competitiveness and mobility is separated in this report into two different sections. This may be a result of the large number of measures that relate to this combined goal area. The other two sections included in the overall At-A-Glance summary, preservation and safety, are related to the agency-wide goals just simply renamed from maintenance and operations and safety and security, respectively (45).

In addition to the overall At-A-Glance summary, the department creates four At-A-Glance summaries that provide a more detailed look at each of the combined goal areas in the agency-wide set of measures. The four detailed At-A-Glance summaries group the goal areas in the same manner as the agency-wide performance measure set:

safety and security, maintenance and operations, economic competitiveness and mobility, and quality of life and environmental stewardship. The summaries include a statement of the goals and a justification for the importance of the goals. They also report time-series graphs for calculable performance measures (performance targets are also included when applicable), and key strategies for improving agency performance for each of the measures (42). Figure 10 shows an example of the detailed At-A-Glance summaries, the At-A-Glance summary for Maintenance and Operations.

2012 PERFORMANCE REPORT
MAINTENANCE & OPERATIONS
AT A GLANCE

THE GOAL: Maintain and operate Florida's transportation system proactively

WHY IT'S IMPORTANT: Florida has invested billions of dollars in roads, rail networks, airports, transit facilities and services, seaports and other elements of the transportation system. Regular maintenance and improvements keep these assets operating efficiently to extend their useful life and can delay the substantial cost of reconstructing or replacing them.

Pavement Conditions

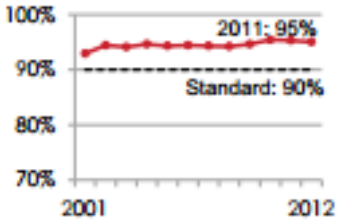
The State Highway System has remained at or near the target of 80% non-deficient throughout the last decade.

Key Strategies:

- Resurface at least 4% of the State Highway System annually
- Reduce the illegal operation of overweight commercial motor vehicles

Bridge Conditions

Over 95% of all Department maintained bridges meet standards, which means Florida bridges do not show evidence of structural deterioration and are not limited by weight.

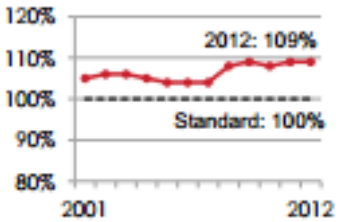


Key Strategies:

- Replace or repair all structurally deficient and weight restricted bridges within 6 years of identification
- Replace all other bridges designated for replacement within 9 years of deficiency identification

Roadway Maintenance

The Department is committed to achieve 100% of the acceptable maintenance standards on the State Highway System. This includes potholes, signs, lighting, mowing, litter removal, etc.



Key Strategies:

- Continue to identify and implement practices which reduce the time and cost of preservation
- Increase efficiencies through use of state-of-the-art technologies and innovative contracting methods

System Operations

Additional roadway and facility improvements by themselves will not solve our traffic problems. Travel choices, technology, access management and land use issues must also be considered.

Key Strategies:

- Increase the use of Intelligent Transportation Systems technology
- Expand the use of electronic toll collection
- Support commuter assistance programs for sharing rides to work
- Coordinate with partners in revising regional evacuation plans

Get more information at: FDOTPerforms.org

Figure 10: FDOT's At-A-Glance Summary for Maintenance and Operations (42)

4.1.5.2 Annual Performance Report

The Annual Performance Report is organized into chapters by goal areas. There are dedicated chapters for safety and security, maintenance and operations, economic competitiveness and mobility, and quality of life and environmental stewardship. In each of the chapters, the goal areas are defined and discussed then the corresponding short-range objectives are identified. The remaining chapters are organized around each of the identified short-range objectives. A justification and an explanation are provided for each of the short-range objectives and charts and tables are provided for the corresponding aforementioned agency-wide performance measures. Figure 11 shows an example of the performance measure charts included in the Annual Performance report, the chart for the number of fatalities and serious injuries due to crashes from 2006 to 2010. This chart, like many other charts included in the report, incorporates two related performance measures into one graphic -- serious injuries in the blue bars and fatalities in the red line. Similar to this chart, past data is included in the charts and graphs for nearly all the other agency-wide performance measures to show the historical trends (42).

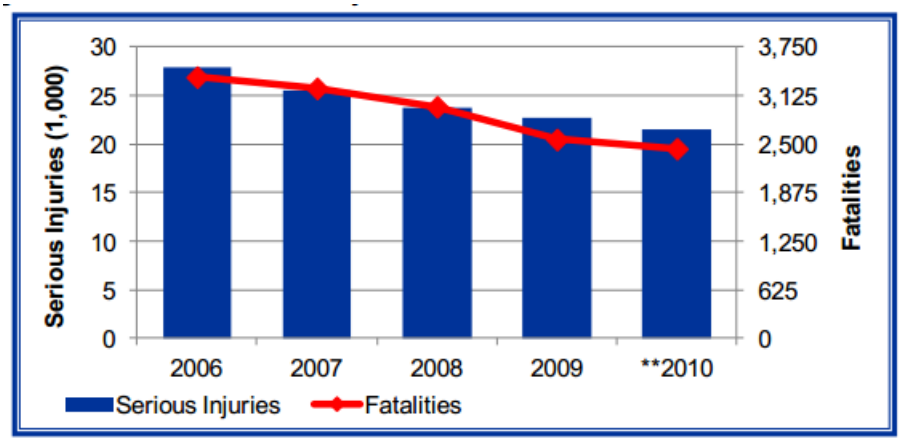


Figure 11: Example Chart from the FDOT 2012 Performance Report Showing Performance Results for Total Serious Injuries and Fatalities (42)

For each of the agency-wide measures, the report contains context about why the measures are important and includes an explanation about how some of the measures are derived. Additionally, the report offers a discussion of the potential influences that may be affecting the trends in the performance and the agency's limitations in addressing outcomes that are heavily influenced by external factors. Also, a set of potential strategies for future improvement are also identified for each of the performance measures and short-range objectives. It is important to note that while there were no performance measures identified for the quality of life and environmental stewardship goal categories, anecdotal examples of the department's performance in these goal areas are discussed in the chapter (42).

4.1.5.3 SIS Performance Brief

The SIS Performance Brief reports results of the set of SIS performance measures. As discussed earlier, the SIS performance measures are strategically aligned with the goals presented in the FTP. This document explains this relationship by discussing the FTP goals and long-range objectives and pointing out that the short-range objectives used to organize this set of performance measures, the SIS performance measures, flow from the FTP goals and objectives. The report provides a brief justification for each of the short-range SIS objectives and charts for each of the corresponding performance measures. An example of the charts is shown in Figure 12, the chart depicting the state highway condition ratings. Just as in the Annual Performance Report, the charts included in the SIS Performance Brief often include multiple performance measures in one graphic and include past data to show the trend in performance. In addition, like the Annual Performance Report, the charts in the SIS

Performance Brief were accompanied by an explanation of the importance of each of the performance measures, a discussion of the factors that potentially influence each of the performance measures, and the identification of agency actions to improve future performance (43).

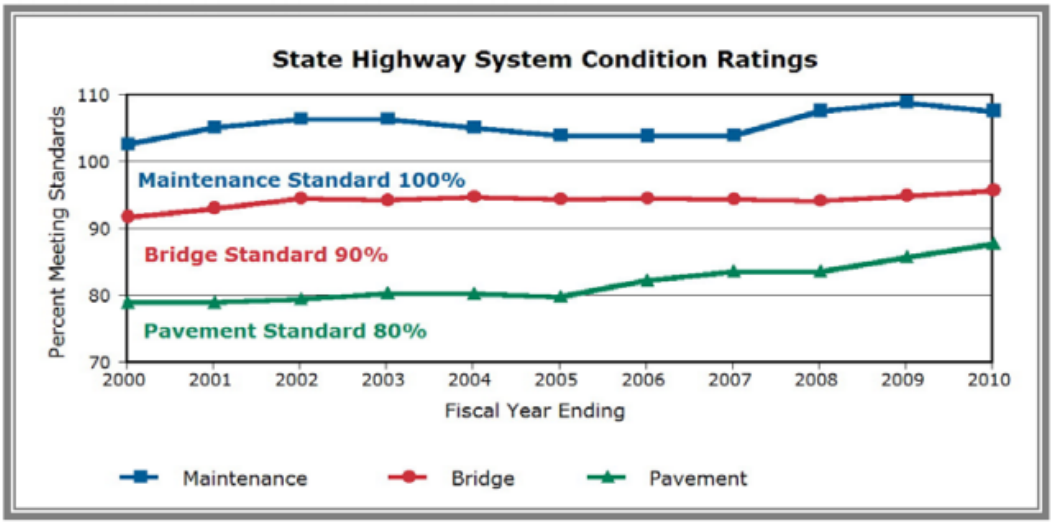


Figure 12: Example Chart from the FDOT SIS Performance Brief Showing Results for the Maintenance, Bridge, and Pavement Ratings (43)

4.1.5.4 Performance Dashboard

The performance dashboard is an interactive webpage on the FDOT website that reports the agency's dashboard performance measures. These dashboard performance measures are organized into five goal areas: safety, project delivery, maintenance, mobility, and accountability. These goal areas are represented on the main screen of the performance dashboard by five freeway guide signs with the name of each of the goal areas written on them. Under each of these guide signs is a traffic signal with red, yellow, and green lights that correspond to not meeting, almost meeting, and meeting the agency's targets, respectively. Figure 13 is a picture of the FDOT performance dashboard home screen. On the home screen of the performance dashboard all goals areas but safety

(which has a yellow traffic signal) are green. The yellow traffic signal under the safety guide sign shows that the agency is almost meeting their safety targets and the green traffic signals under each of the other guides signs shows that the agency is meeting the targets for each of the other goal areas (44).

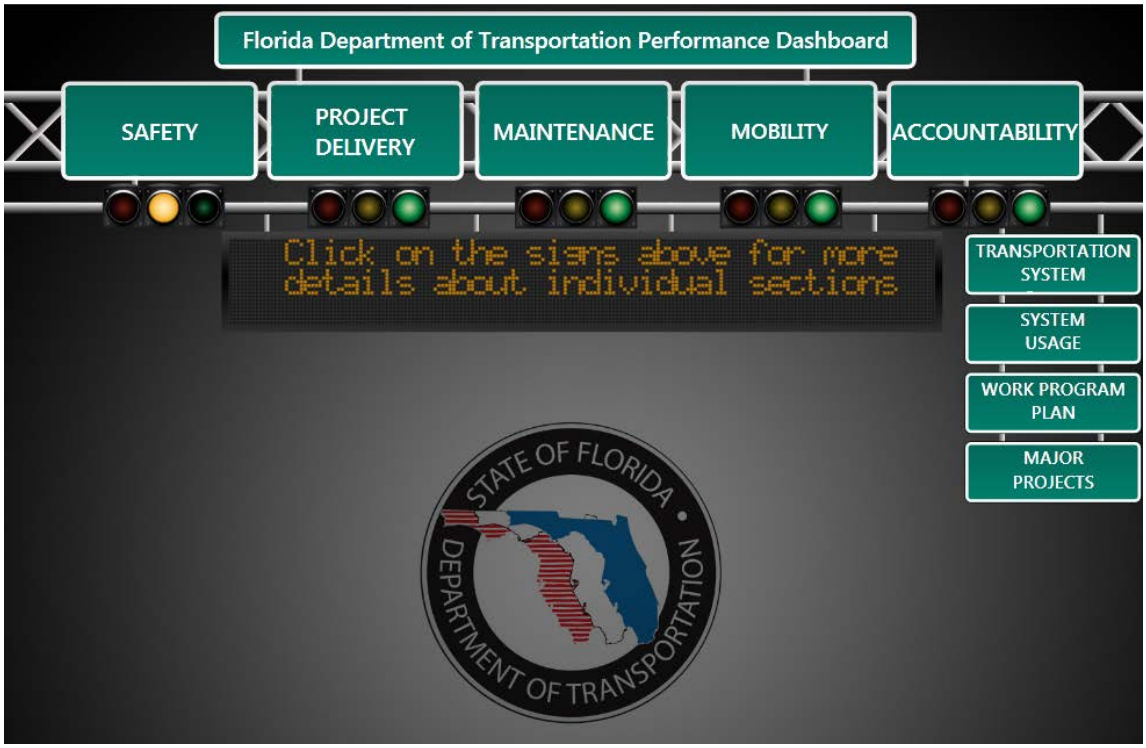


Figure 13: Home Screen of the FDOT Performance Dashboard (44)

Five detailed goal area screens can be accessed by clicking on each of the appropriate guide signs on the performance dashboard home screen. Figure 14 shows an example of one of these detailed screens, the FDOT safety performance dashboard. These detailed goal area dashboards have two components: a table component and a graph component. In the table component, there are four columns. The first, titled "measure," lists the each of the measures aligned with the appropriate goal area. The second column, titled "objective," identifies the targets for the corresponding performance measures. The third column, titled "result," depicts the numerical value calculated for each of the

performance measures. Finally, the last column, titled "performance," contains red, yellow, and green indicators that display whether the agency performance has not met the target, has almost met the target, or has met the target, respectively, for each of the corresponding performance measures (44).

The graph component of the goal area performance dashboard uses historical data of past agency performance to show performance trends. Only one performance measure can be displayed in the graph component at a time; however, the user can switch to other performance measures by simply clicking on the measure's row in the table component of the goal area dashboard. In the graph, the actual values of the performance measure are displayed as blue bars and the targets are shown as red lines (44).

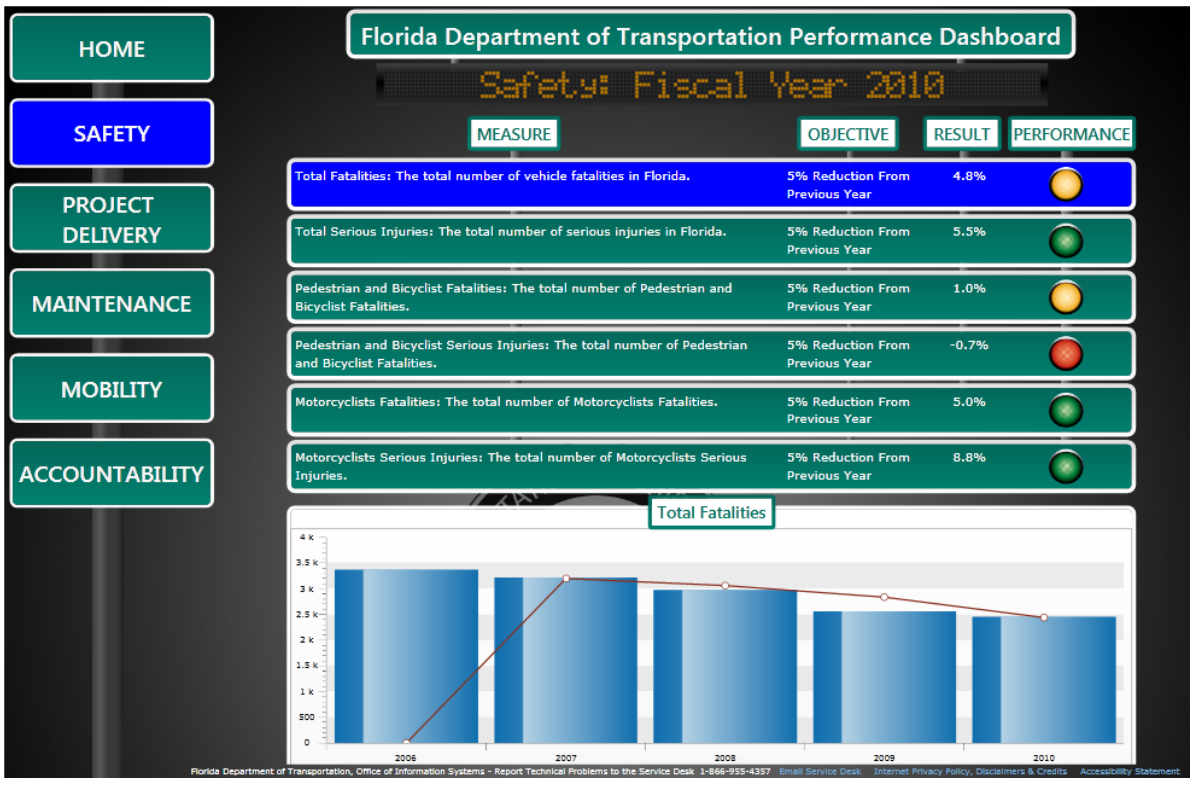


Figure 14: FDOT Safety Performance Dashboard (44)

4.1.6 Multimodal

From the FDOT website and state planning and performance measurement documents, there is no evidence to suggest that the agency has a formalized process or application for undertaking multimodal tradeoff analysis. However, all three of FDOT's strategic, statewide performance measurement sets include a multimodal perspective. In the following sections, the modal inclusivity of each of FDOT's three sets of performance measures will be examined.

4.1.6.1 Agency-Wide Performance Measures

The agency-wide set of measures is modally inclusive, particularly for the goal areas of safety and security and economic competitiveness and mobility. The safety and security goal area includes measures that address bicycles, pedestrians, transit systems, and automobiles. One such measure is the total serious injuries and fatalities due to crashes. This measure includes bicycle and pedestrian injuries and with automobile fatalities, providing for a mode-neutral measure. In addition to this mode-neutral measure, there are modally-oriented safety and security performance measures that address non-highway modes. Included in these non-highway measures are the serious injuries and fatalities for bicycles and pedestrians, the amount of incidents, fatalities, injuries, and property damage for the top ten transit agencies in the state, and the total number of fixed route transit incidents in the state. The economic competitiveness and mobility goal area also includes mode-neutral and non-highway measures. The lone mode-neutral measure for economic competiveness and mobility is the benefit-cost ratio of investments in the FDOT work program. This measure is the product of an economic reduction that converts the benefits of all FDOT investments, regardless of mode, into a

monetary value and divides that value by the total agency expenditure. There are also non-highway performance measures that primarily address transit. These measures include the number of passenger trips and revenue miles on fixed route transit, the number of transportation disadvantaged (TD) transit trips, the operating cost per passenger trip and per TD trip, and the annual percentage change of transit ridership compared to the annual percentage change in population.

4.1.6.2 SIS Performance Measures

The SIS performance measure set is the most multimodal of the three sets, as it is used to guide agency investments for the state's most important transportation facilities for all modes. The set includes performance measures relating to freight transportation, where the other sets of measures are largely focused on passenger transportation. It also contains a number of both mode-neutral and non-highway measures. The mode-neutral measures included in the set are the value of Florida's international imports and exports, the state's energy consumption by sector, and the gross greenhouse gas emissions from fuel by the transportation sector. The non-highway modes covered by the modal measures include air travel, transit, intercity passenger rail, and maritime passenger travel. The measures that represent these non-highway modes are the percent of on-time flight arrivals and departure at SIS airports and the growth trends in person travel for transit, Amtrak service, airlines, and cruises.

4.1.6.3 Dashboard Performance Measures

The final set of performance measures, the dashboard performance measures, focuses largely on the agency's organizational performance; however, the measures representing transportation system performance include mode-neutral and non-highway

performance measures. As with the agency-wide set of measures, the dashboard performance measure set includes the mode-neutral measure for the total number of fatalities, including bicycle, pedestrian, and automobile. The set also includes mode-specific measures for non-highway modes, such as the number of serious injuries and fatalities for both pedestrians and bicyclists and the growth rate in public transit ridership compared to the population growth rate.

4.1.7 MAP-21

FDOT has demonstrated a commitment to meeting the legislative mandates for performance measurement in MAP-21. In February 2013, FDOT completed its first MAP-21 Performance Report, three years ahead of statutory requirements for annual performance reports. While the specific set of national performance measures has yet to be developed through federal rulemaking, the agency used the set of national goals identified in the legislation to report a set of strategically aligned performance measures. For each of the national goal areas the report identifies potential data issues and other issues involved in implementing a national performance measure. Additionally, FDOT selected recommended performance measures for each of the goal areas and reported the level of performance for each of these measures (46).

4.2 North Carolina Department of Transportation

The following analysis of the North Carolina Department of Transportation (NCDOT') performance measurement program is based on the following resources from the NCDOT website: NCDOT's 2040 Plan, Our Metrics, the 2012 Annual Performance Report, the Organizational Performance Dashboard, the Quarterly Performance Scorecard from the fourth quarter of the 2012 state fiscal year, the Strategic Prioritization page on

the agency's website, and the Prioritization 2.0 Presentation. The section relating to the multimodal nature of NCDOT's performance measurement program also contains a summary of the agency's efforts in performing multimodal tradeoff analyses at the statewide, strategic level

4.2.1 Strategically Aligned

NCDOT's 2040 Plan, the state's federally mandated LRSTP, is a policy-based plan that provides direction for determining the state's transportation priorities. Part of this plan defines the agency's mission and goals. Figure 15 depicts NCDOT's mission and goals. The goals, which flow directly out of the mission, are to make the transportation network safer, make the transportation network move people more efficiently, make infrastructure last longer, make the organization a place that works well, and make the organization a great place to work (47).

Figure 15: NCDOT's Mission and Goals (47)

What was identified in the literature as an objective is not used by the NCDOT in its strategic planning process. Instead, the agency's performance measures are directly linked to the goals without the use of the intermediary objectives. Like FDOT, NCDOT does not specify a set of performance measures for each of their goals in the LRSTP (47). The agency identifies its two sets of performance measures in other documents that are updated on a more regular basis. In the following sections, this thesis will examine NCDOT's two sets of performance measures, the executive performance measures and the dashboard performance measures.

4.2.1.1 Executive Performance Measures

A document on the NCDOT website, Our Metrics, identifies the set of executive performance measures for each of the agency goals and establishes a target for the current state fiscal year (48). Table 11 was created from information in Our Metrics and shows the goals, performance measures, and targets included in NCDOT's set of executive performance measures for the 2013 state fiscal year. The left column shows the goal area, the center column lists the performance measures for each of the goal areas, and the right column identifies the targets for each of the performance measures. As can be seen from the table, each of the performance measures used is directly linked to an agency goal.

Table 11: Goals, Performance Measures, and Targets in NCDOT's Set of Executive Performance Measures

Goal	Performance Measure	Target
Make our transportation network safer	Statewide network crash rate	234 or less
	Percentage of surveyed North Carolina drivers using a safety belt	90.0% or greater
Make our transportation network move people and goods more efficiently	Average statewide accident clearance time	70 min. or less
	Travel time index for surveyed interstates	1.04 or less
	Percentage of planned ferry runs completed as scheduled	95.0% or greater
	Percentage of passenger trains arriving on schedule	80.0% or greater
	Percentage change in public transit ridership	+5% or greater
	Percentage change in Port Authority cargo movements (container and breakbulk cargo)	+5% or greater
Make our infrastructure last longer	Percentage of bridges rated in good condition	65.0% or greater
	Percentage of pavement miles rated in good condition	70.0% or greater
	Average highway feature condition scores (excluding pavement and bridges)	84 or greater
	Average rest area condition scores	90 or greater
Make our organization a place that works well	Percentage of work program STIP projects on schedule	85% or greater
	Percentage of centrally managed STIP projects on schedule	85% or greater
	Percentage of division managed STIP projects on schedule	85% or greater
	Percentage of municipal and locally managed STIP projects on schedule	85% or greater
	Percentage of division-managed non-STIP projects on schedule	85% or greater
	Percentage of construction projects completed on schedule	85% or greater
	Total budget overrun for completed construction projects	5% or less
	Percentage of NCDOT's total budget expended on external goods, materials and services	80.0% or greater
	Percentage of the overall budget for administrative costs	7.6% or less
	Percentage of the total program budget paid to minority- and women-owned businesses	10.7% or greater
	Average customer wait-time at DMV facilities that track transactions	24 min. or less
	Average statewide environmental compliance score on construction and maintenance projects	7.5 or greater
	Percentage of surveyed customers satisfied with transportation services in North Carolina	75% or greater
Make our organization a great place to work	Percentage of employees retained after three years	90% or greater
	Employee safety index	6.16 or less

These performance measures are subject to change from year to year. The 2012 Annual Performance Report shows that the performance measure set to be used in 2013 differs from that used in 2012. Each year, the annual performance report communicates the agency's performance for that year and identifies the suite of performance measures to be used in the following state fiscal year (49). This practice of including the current set of executive performance measures with the future set of performance measures in the same document provides a traceable record of how such measures change over time. However, this also raises an interesting issue about performance tracking if such measures are allowed to change on a year-by-year basis. No in-depth discussion of this issue was found in the literature review. An appropriate balance between (1) year-to-year measurement consistency and (2) a responsiveness to important changes in either real world issues or improved data and methodological options, seems likely to come up as state DOTs gain experience with such measures.

4.2.1.2 Dashboard Performance Measures

The set of performance measures used in the organizational performance dashboard will be referred to as the set of dashboard performance measures. Each of the performance measures used in the dashboard is aligned with an NCDOT goal area. Table 12 shows the five NCDOT goal areas and the corresponding performance measures in the agency's set of dashboard performance measures. The performance measures in bold font are the measures used as the key indicator in the dashboard and the other measures in standard font are the measures presented on the detailed pages for each of the goals (50). Each of the dashboard performance measures are clearly aligned with the goal areas.

Table 12: Goals and Performance Measures in the NCDOT Set of Dashboard Performance Measures

Goal	Performance Measure
Make our transportation network safer	**Fatality rate**, crashes, fatalities, injuries, crash rate, and injury rate.
Make our transportation network move people and goods more efficiently	**Average clearance time**, ferry service reliability (overall and individual routes), rail service customer satisfaction and ridership, percent reduction in VMT from public transportation, and percent of strategic highway corridors with recurring congestion.
Make our infrastructure last longer	**Infrastructure health rating**, bridge health index, pavement condition, and roadside feature condition.
Make our organization a place that works well	**TIP delivery rate**, percent of plans completed and bids opened on time, percent of right of way plans completed on time, percent of construction projects completed on schedule, percent of construction projects completed on budget, and average state environmental compliance score.
Make our organization a great place to work	**Employee engagement score**, commitment score, discretionary effort score, and intent to stay score (from responses to agency-wide survey).

4.2.1.3 Summary

Both sets of performance measures used by NCDOT are clearly aligned with the agency goals without the use of intermediary objectives. Additionally, neither of these sets of measures are identified and aligned in the state's LRSTP. Instead, NCDOT uses the same flexible approach to performance measure development as FDOT. The executive performance measures are established in two documents, Our Metrics and the Annual Performance Report. In the Annual Performance report, the current executive performance measures are identified along with the future performance measures, which provides a traceable history of how the performance measure set has changed over time. The dashboard performance measures are identified on the organizational performance dashboard and are periodically updated. This flexible approach to performance measure development used by NCDOT has two advantages. It allows the agency to develop two separate, but still strategically aligned, sets of performance measures. It also allows the

agency to make changes to the performance measures included in each of the sets on a regular basis.

4.2.2 Balanced

NCDOT does not classify any of its measures as being input, output, or outcome measures. In addition, the ambiguous nature of applying the definitions of input, output, and outcome measures makes it difficult to individually classify an agency's set of measures. Therefore, the balance of the program will be examined at the set level. The set of executive measures used by NCDOT appears to be fairly balanced. While the majority of measures seem to be outcome measures, there appears to be a number of output and input measures included in the set, particularly in the goal area "make our organization a place that works well." This may be because this goal area tracks the organizational performance, rather than system performance, and organizational performance measures tend to be output measures, as they track the level of an agency's activities.

4.2.3 Manageable

NCDOT has a very manageable performance measurement program. The agency has one set of executive performance measures, which includes 27 performance measures, and a smaller set of five key dashboard performance measures (one for each of the agency's goals). The set of executive performance measures appears to be designed for use by agency officials and planners. Given that, 27 measures seem to be an appropriate number of measures for the intended audience. On the other hand, the set of dashboard performance measures is intended for use by the public. The public does not typically require as much performance information as NCDOT officials, so a reduced set of measures is well suited for public information purposes. In case the public requires

more detailed performance information, the effective design of the dashboard, discussed later under communicable, allows the public to access additional performance information for each of the goals.

4.2.4 Calculable

Nearly all of NCDOT's executive performance measures are calculable. In the 2012 set of executive performance measures, NCDOT lacked the data necessary to calculate only one proposed performance measure, percentage increase in transit ridership because it is the first year the agency has tracked the performance measure. All other executive performance measures were calculated throughout the year. In the performance dashboard, only measures that can be calculated are included on the main dashboard and the detailed performance information pages for each of the goals. Therefore, all of the performance measures included in the dashboard set of measures can be calculated.

In addition to nearly all of NCDOT's performance measures being calculable, the vast majority of NCDOT's measures have been calculated in a repeatable manner. The performance measures included in the performance dashboard and the accompanying detailed performance information pages are all calculated and updated regularly. The measures in the set of executive performance measures are recalculated and updated quarterly. However, for a couple of the executive performance measures, the percentage of planned passenger trips arriving on schedule and the total budget overrun for completed construction projects, not much past historical data exists, as they were not tracked until 2012. NCDOT, as will be discussed in further detail below in the communicable section, does not present the historical performance information for the

executive performance measures. Rather, the agency uses a color code to denote the trend of the measure. Despite the rich amount of data collected by NCDOT for its performance measurement program, no evidence could be found from state planning documents or performance measurement documents that suggests that NCDOT forecasts the executive performance measures or dashboard performance measures for future performance levels under alternative funding scenarios.

4.2.5 Communicable

NCDOT communicates its performance in one of three media: the organizational performance dashboard, the annual performance report, and the quarterly performance scorecards. Each of these media will be examined in the following sections.

4.2.5.1 Organizational Performance Dashboard

The organizational performance dashboard is posted on the department's website and is updated the most frequently. Figure 16 is an image of NCDOT's performance dashboard. The dashboard has five tabs that relate to each of the agencies goals. The tabs are named after the performance measure that is used as the key indicator for each of the goal areas. The names used are fatality rate, incident duration, infrastructure health, delivery rate, and employee engagement. The numerical calculation for each of the performance measures as well as a dial styled after a car's speedometer. The dial has a polychromatic scale transitioning from red to yellow to green for performance measures where higher values correspond to better performance, like infrastructure health or delivery rate. The scale is reversed, transitioning from green to yellow to red, for performance measures where higher values correspond to poorer performance, like fatality rate and incident duration. When one of the tabs is selected, the portion of the

dashboard below the tabs displays more detailed information about the selected performance measure. Included are an enlarged image of the performance measure's dial and a description of the measure, including the goal area the measure is aligned with and the method in which it is calculated. In the detailed information section, there is also a link that can be clicked to access even more detailed information for the performance measure and the goal area it is aligned with (50).

Figure 16: NCDOT's Performance Dashboard (50)

4.2.5.2 Annual Performance Report

The annual performance report published by NCDOT serves a number of functions, it provides background information about the agency, provides a financial snapshot of the agency, reports the agency's performance through a scorecard and a list of key accomplishments, presents additional information about each of the agency's programs, and selects the performance measures and corresponding targets to be used in the following fiscal year. The analysis of this report will focus solely here on the reporting of the agency's performance in the annual performance report. Though the report includes a section detailing the agency's major accomplishments over the last year,

the report utilizes a scorecard to report the "executive performance measures." There are five columns in the scorecard. The first column lists the agency's goals, while the second column lists the performance measures. The performance measures listed in the second column are grouped together with the goal they are aligned with. The third column in the scorecard reports the result from the previous year, and the fourth column displays the target value for the current year for each of the performance measures. The fifth column in the scorecard reports the results for the current year and the cell in which the result is reported is colored green, yellow, or red. These colors correspond to met or exceeded target, came within five percent of target, and fell below target, respectively. Under the goal section, an explanation of strategies to improve performance is given for each of the performance measures that fell below and were not within five percent of the target (49). Figure 17 shows the NCDOT Performance Scorecard for FY 2012.

Met or Exceeded Target | Within 5% of Target | Below Target

Goal	Defined Performance Measure	SFY2011 Result	SFY2012 Target	FY2012 Result
Safety: Make our transportation network **safer**	Statewide network crash rate[1]	233	235 or less	230
	Statewide network fatality rate[1]	1.25	1.64 or less	1.15
	Percentage of surveyed North Carolina drivers using a safety belt[2]	89.5%	90% or greater	88.7%[2]
Mobility: Make our transportation network move people and goods more **efficiently**	Average statewide accident clearance time	66 min.	70 min. or less	61 min.
	Travel time index of surveyed interstates	1.02	1.04 or less	0.98[5]
	Percentage of planned ferry runs completed as scheduled	98%	95% or greater	97%
	Percentage of planned passenger trains arriving on schedule[4]	new measure[5]	80% or greater	58.4%
	Percentage increase in public transit ridership[4]	new measure	5% or greater	data unavailable
	What are we doing? **Percentage of planned passenger trains arriving on schedule** A number of projects are planned to be completed over the next few years that will add parallel tracks where passenger and freight trains now share a single track. In addition, the construction of highway/railroad bridges in the Raleigh to Charlotte corridor, refurbished locomotives and improved station platforms will also improve reliability.			
Infrastructure Health: Make our infrastructure **last longer**	Percentage of bridges rated in good condition	71.8%	65% or greater	66.2%[6]
	Percentage of pavement miles rated in good condition[2]	67.8%	70% or greater	68.9%
	Average highway feature condition scores (excluding pavement and bridges)[2]	87.1	84 or greater	89.7
	Average rest area condition scores	94	90 or greater	97
Make our organization a place that **works well**	Percentage of work program projects on schedule[3]	73%	85% or greater	75%[3]
	a. Percentage of centrally-managed STIP projects let on schedule[7]			80%
	b. Percentage of division-managed STIP projects let on schedule[7]			72%
	c. Percentage of municipal- and locally-managed STIP projects let on schedule[7]			51%
	Percentage of construction projects completed on schedule	77%	80% or greater	85%
	Total budget overrun for completed construction projects[4]	new measure	5% or less	-2%
	Percentage of the overall budget for administrative costs	5.9%	7.6% or less	5.5%
	Percentage of the total program budget paid to minority- and women-owned businesses	10.5%	10.2% or greater	12.3%
	Average customer wait time at DMV facilities that track transactions	24 min.	17 min. or less	25 min.
	Average statewide environmental compliance score on construction and maintenance projects	8.6	7.5 or greater	8.7

Figure 17: NCDOT's Performance Scorecard for FY 2012 (49)

4.2.5.3 Quarterly Performance Scorecards

The quarterly performance scorecard is similar to the performance scorecard used in the annual performance report. The quarterly performance scorecard has seven columns. The first column contains the agency's goals. The second and third columns contain the performance measure identification number and the name of the performance measure respectively. These measures are horizontally aligned with the goals they

correspond to. The fourth column contains the previous fiscal year's result and the fifth column contains the current fiscal year's target for each of the performance measures. The sixth column in the scorecard contains the year-to-date result of the performance measure up to the most recent quarter. The cells in which the year-to-date values are contained are shaded red, yellow or green. These colors correspond to values that do not meet the annual target, are within five percent of meeting the annual target, and meeting or exceeding the target, respectively. The final column of the quarterly scorecard displays the trend for each of these performance measures with a red, yellow, or green circle. The red, yellow, and green circles signify measures that have negative trends, measures that have negative trends but still meet expectations, and measures with positive trends, respectively. Figure 18 shows the quarterly performance scorecard for the third quarter of the 2012 state fiscal year (SFY). These quarterly performance scorecards provide a media for NCDOT to track progress throughout the year towards meeting the annual targets and reporting the progress to the public (51).

Goal	#	Performance Measure	SFY11 Result	SFY12 Target	SFY YTD Result (as of 03/31/12)	Trend
Make our transportation network safer	1.1	Statewide network crash rate	233[1]	235 or less	235	●
	1.2	Statewide network fatality rate	1.25[1]	1.64 or less	1.15	●
	1.3	Percentage of surveyed North Carolina drivers using a safety belt	89.5%[2]	90.0% or greater	89.5%[2]	●
Make our transportation network move people and goods more efficiently	2.1	Average statewide accident clearance time	66 min.	70 min. or less	62 min.	●
	2.2	Travel time index for surveyed interstates[5]	1.02	1.04 or less	1.02[5]	●
	2.3	Percentage of planned ferry runs completed as scheduled	98%	95.0% or greater	97%	●
	2.4	Percentage of planned passenger trains arriving on schedule[4]	New Measure	80.0% or greater	64%	●
	2.5	Percentage increase in public transit ridership[4]	New Measure	5% or greater	Results not available	N/A[4]
Make our infrastructure last longer	3.1	Percentage of bridges rated in good condition	71.8%[6]	65.0% or greater	67%	●
	3.2	Percentage of pavement miles rated in good condition	67.8%[2]	70.0% or greater	67.8%[2]	●
	3.3	Average highway feature condition scores (excluding pavement and bridges)	87[2]	84 or greater	87[2]	●
	3.4	Average rest area condition scores	94	90 or greater	95	●
Make our organization a place that works well	4.1	Percentage of work program projects on schedule[3]	73%[8]	85% or greater	73%[3]	●
		A. Percentage of centrally managed STIP projects let on schedule[3]			91%	
		B. Percentage of division managed STIP projects let on schedule[3]			66%	
		C. Percentage of municipal and locally managed STIP projects let on schedule[3]			42%	
	4.2	Percentage of construction projects completed on schedule	77%	80% or greater	87%	●
	4.3	Total budget overrun for completed construction projects[4]	New Measure	5% or less	-0.9%	●
	4.4	Percentage of the overall budget for administrative costs	5.9%	7.6% or less	5.5%	●
	4.5	Percentage of the total program budget paid to minority- and women-owned businesses	10.5%	10.2% or greater	12.2%	●
	4.6	Average customer wait time at DMV facilities that track transactions	24 min.	17 min. or less	26 min.	●
	4.7	Average statewide environmental compliance score on construction and maintenance projects	8.6	7.5 or greater	8.7	●
Make our organization a great place to work	5.1	Average time to hire new employees	76 days	60 days or less	68 Days	●
	5.2	Employee engagement survey score	5.23[2]	5.0 or greater	5.32	●
	5.3	Employee safety index	4.88	6.16 or less	2.32	●

Figure 18: NCDOT's Quarterly Performance Scorecard for the Third Quarter of SFY 2012 (51)

4.2.6 Multimodal

4.2.6.1 Multimodal Performance Measurement

Both sets of NCDOT's performance measures, the executive performance measures and the dashboard performance measures, include a multimodal perspective. In the executive performance measures, the three goal areas that address transportation system attributes rather than organizational performance are the goals relating to safety, mobility, and infrastructure health. While the performance measures used for the safety

and infrastructure health goal areas are auto-centric, the performance measures for the goal relating to mobility track the performance of many different modes. The measures, percentage of planned ferry runs completed as scheduled, percentage of passenger trains arriving on schedule, percentage change in public transit ridership, and the percentage change in Port Authority cargo movements, give agency decision-makers insight into the performance of the state's ferries, intercity passenger rail system, transit system, and freight facilities, respectively.

The set of dashboard performance measures also includes many modal measures for the non-highway modes. Like with the executive performance measures, the multimodal aspect of the dashboard performance measures is incorporated in the goal area relating to mobility. While the key indicator used for mobility on the dashboard is an auto-centric measure, many of the measures on the detailed information page relate to non-highway modes of transportation. These include ferry service reliability for both individual routes and the overall system, rail service customer satisfaction ratings and ridership, and the percent reduction in VMT from public transportation.

4.2.6.2 Multimodal Tradeoff Analysis

NCDOT uses a performance-driven approach to making decisions about major transportation investments. The approach weighs the existing and future conditions, the projected benefits of the projects, the multi-modal nature of the project, and local input into the analysis. The prioritization project begins by categorizing similar project into what the agency calls "prioritization buckets" and comparing the projects within each of the buckets using performance data. The main prioritization buckets that are examined are for highway mobility, highway modernization, bicycle and pedestrian, and public

transportation, and the criteria are based on the agency's three primary goals of Safety, Mobility, and Infrastructure Health. Highway mobility and modernization projects are scored based on quantitative data, like current congestion, safety, and pavement conditions, travel time benefit/cost ratio, and output from the TREDIS (52) economic impact model, based on local input from the MPOs, and based on the extent to which the project benefits more than one mode of transportation. Bicycle and pedestrian projects are scored based on quantitative data, like acquired right-of-way, density, and vehicle crashes with bicycles or pedestrians, in addition to local input from MPOs. The public transportation bucket as well as the other minor buckets is ranked by NCDOT experts using quantitative data and local expertise (53) (54).

Once the projects are prioritized within the buckets, NCDOT holds numerous investment summits where stakeholders provide input on how the agency resources should be invested. The discussions in these summits are aided by what the agency calls Performance LOS, an A-F scale that represents the quality of service provided to system users for each of the prioritization buckets (53) (54). The agency uses data that is "reliable, repeatable, and affordable" to calculate the performance LOS for each of the buckets (54). Examples of the performance data used to calculate the performance LOS are the percentage of miles with volume-to-capacity ratios less than .80 for highway mobility, the percentage of miles that meet NCDOT's Paved Shoulder Policy (where paved shoulders are required for highway modernization), the bicycle-pedestrian index for bicycle and pedestrian facilities, and passenger trips per year for public transportation. NCDOT then ties the levels of investment to the future performance for each of the buckets to aid stakeholders in assigning money between the buckets. The result of the

investment summit is an investment strategy that then guides the development of the STIP (53) (54).

The process used by NCDOT for the prioritization of projects across modes appears to follow the same methodology developed by Cambridge Systematics for multimodal tradeoff analysis. The scoring model is used to prioritize projects within the buckets, the equivalent of what are called programs in the literature, then the performance LOS is used to support comparisons across the buckets.

4.3 Maryland Department of Transportation

The following analysis of the Maryland Department of Transportation (MDOT) performance measurement program is structured solely around the six evaluation criteria identified in the existing literature. The analysis is based on the statewide planning and performance measurement documentation provided on the agency's website. These documents include the Maryland Transportation Plan, the Performance Dashboard, and the 2013 Attainment Report.

In order to provide sufficient background information, it is important to highlight the unique organizational structure used by MDOT because the agency's organizational structure impacts their performance measurement program. MDOT is a rather unique state DOT in how it is organized. While most states house all modes of transportation in one agency, MDOT has five administrations with certain "functional responsibilities" for the state's transportation facilities and services. The five administrations housed under MDOT are the Maryland Aviation Administration (MAA), the Maryland Port Administration, the Maryland Transit Administration (MTA), the Motor Vehicle Administration (MVA), and the State Highway Administration (SHA). Additionally

MDOT is linked to another agency, the Maryland Transportation Authority (MDTA), which is responsible for the state's toll facilities. While the MDTA is an independent agency, the Secretary of MDOT serves as the chair of the MDTA. Even though the functional responsibilities are delegated to the administrations, MDOT retains responsibility for coordinating statewide transportation planning across all modes and establishing the statewide transportation policy (55). This unique organizational structure is clearly reflected in the structure of the performance measurement program, as discussed further below.

4.3.1 Strategically Aligned

The Maryland Transportation Plan (MTP), last updated in 2009, establishes the mission and goals for the Maryland Department of Transportation and its modal administrations. The goals established in the plan include quality of service, safety and security, system preservation and performance, environmental stewardship, and connectivity for daily life. For each of these goals the plan provides additional information about the goals, the objectives aligned with the goals, current programs and efforts to address the goals, and future strategies for making progress towards the goals (55). Table 13 lists MDOT's goals and objectives and was created from information contained in the MTP.

Table 13: MDOT Goals and Objectives from the MTP

Goal	Objectives
Quality of Service	• Enhance customer experience and service. • Provide reliable and predictable travel time across modal options for people and goods. • Facilitate coordination and collaboration with agency partners and stakeholders
Safety and Security	• Reduce the number and rate of transportation related fatalities and injuries. • Secure transportation assets for the movement of people and goods. • Coordinate and refine emergency response plans and activities.
System Preservation and Performance	• Preserve and maintain the existing transportation network. • Maximize operational performance and efficiency of existing systems.
Environmental Stewardship	• Coordinate land use and transportation planning to better promote Smart Growth. • Preserve and enhance Maryland's natural, community, and historic resources. • Support initiatives that further our commitments to environmental quality.
Connectivity for Daily Life	• Provide balanced, seamless, and accessible multimodal transportation options for people and goods. • Facilitate linkages within and beyond Maryland to support a healthy economy. • Strategically expand network capacity to manage growth.

While the MTP provides in-depth information with regard to the established agency goals, the plan stops short of prescribing the strategic performance measures to be used by the agency. The plan does, however, specifically state that the goals and objectives formulated in the MTP would serve as a framework for the development of a set of agency-wide performance measure in the state's performance reporting medium, the Attainment Report (55). This flexible approach to the development of performance measures is similar to that of FDOT and NCDOT.

4.3.1.1 Agency-Wide Performance Measures

The most recent Attainment Report, from 2013, identifies the agency-wide performance measures and organizes them around the goal areas that were detailed in the MTP. While the objectives for each of the goals are discussed, there is no clear linkage of the performance measures to the objectives established in the MTP. Instead, the performance measures used by the agency are directly linked to the agency goals that

they support. Table 14 shows the strategic alignment of MDOT's goals and strategic performance measures. This table was created using the goals established in the MTP and the performance measures that were identified in the Attainment Report. The agency goals are listed in the left column and the performance measures are listed in the right column, horizontally aligned with the agency goals they support. In addition, as was discussed earlier, MDOT is composed of many modal administrations. The strategic performance measures tracked at the agency level are actually a compilation of measures that are tracked by the agency's modal administrations. In the parentheses next to the performance measures, the name of the agency/agencies in charge of tracking the performance measure is/are identified (56).

Table 14: MDOT's Goals and Performance Measures in the Set of Agency-Wide Performance Measures

Goal	Performance Measure
Quality of Service	• Percent of BWI Marshall customers rating the airport "good" or "excellent" on key services (MAA) • Average truck turn-around time at Seagirt Marine Terminal (MPA) • Percent of MTA service on time (MTA) • MTA customer satisfaction rating (MTA) • Overall customer satisfaction of E-Z Pass® customers (MDTA) • Percent of toll transactions collected electronically (MDTA) • MVA branch office customer visit time versus customer satisfaction rating (MVA) • Maryland driver satisfaction rating (SHA) • Percentage of the Maryland SHA network in overall preferred maintenance condition (SHA)
Safety and Security	• BWI Marshall crime rate (MAA) • Number of repeat discrepancies in the annual FAA's Federal Aviation Regulation inspection (MAA) • Rate of airfield ramp incidents and accidents per 1,000 operations (MAA) • MPA compliance with the Maritime Transportation Security Act of 2002 (MPA) • Customer perceptions of safety on the MTA system (MTA) • Preventable accidents per 100,000 vehicle miles (MTA) • Percent of Homeland Security REAL ID Act benchmarks achieved

	(MVA) • Number of bicycle and pedestrian fatalities and injuries on all Maryland roads (MVA/SHA) • Annual number of traffic fatalities and personal injuries on all roads in Maryland (MVA/SHA/MDTA)
System Preservation and Performance	• Airline cost per emplaned passenger (MAA) • Non-airline revenue per emplaned passenger (MAA) • Adequate dredge material placement capacity remaining for Harbor and Bay maintenance and new work dredging (MPA) • Revenue versus operating expense (MPA) • Operating cost per passenger trip (MTA) • Operating cost per revenue vehicle mile (MTA) • Passengers per revenue vehicle mile (MTA) • Cost per transaction (MVA) • Alternative service delivery transactions as percent of total transactions (MVA) • User savings for the traveling public due to incident management (SHA) • Percent of roadway miles with acceptable ride quality (SHA/MDTA) • Number of bridges and percent that are structurally deficient (SHA/MDTA)
Environmental Stewardship	• Transportation-related emissions by region (MDOT) • Transportation-related greenhouse gas emissions (MDOT) • Transportation emission reduction measures-daily reductions in vehicle trips and VMT (MDOTT/MTA) • Acres of wetlands or wildlife habitat created, restored, or improved since 2000 (MPA) • Compliance rate and number of vehicles tested for Vehicle Emissions Inspection Program versus customer wait time (MVA) • Acres of wetlands restored and miles of streams restored (SHA) • Totals fuel usage of the light fleet (SHA) • Reduction in vehicle miles traveled through park-and-ride usage (SHA) • Travel Demand Management- total park and ride spaces and average weekday utilization (SHA/MTA)
Connectivity for Daily Life	• Number of nonstop airline markets served (MAA) • International cruises using the Port of Baltimore (MPA) • Port of Baltimore foreign cargo and MPA general cargo tonnage (MPA) • Annual revenue vehicle miles of service provided (MTA) • Average weekday transit ridership (MTA) • Percent of information system availability compared to total number of records maintained (MVA)

	• Percentage of State-owned roadway directional miles within urban areas that have sidewalks and percent of sidewalks that meet ADA compliance (SHA) • Percentage of State-owned roadway centerline miles with a bicycle level of comfort grade "D" or better and directional mileage of SHA-owned highways with marked bike lanes (SHA) • Percent of freeway lane-miles and arterial lane-miles with average annual volumes at or above congested levels (SHA/MDTA)

4.3.1.2 Dashboard Performance Measures

MDOT also reports a smaller set of performance measures that were derived from the set of agency-wide performance measures on its performance dashboard. This set of measures will be referred to here as the dashboard performance measures. All but two of the dashboard performance measures are taken directly from the agency-wide performance measures. Therefore, the dashboard performance measures are essentially a subset of the agency-wide performance measures. In addition, all of the dashboard performance measures are clearly linked to the agency's goals on the performance dashboard. Table 15 was created from information contained on MDOT's performance dashboard and shows the strategic alignment of MDOT's dashboard performance measures with the agency goals. The goals are listed in the left column and the aligned performance measures are identified in the right column. The italicized performance measures are the two performance measures that were not directly taken from the agency-wide performance measure set (57).

Table 15: MDOT's Goals and Performance Measures in the Set of Dashboard Performance Measures

Goal	Performance Measure
Quality of Service	• Percent of BWI Marshall customers rating the airport "good" or "excellent on key services • Percent of MTA service on time • MTA customer satisfaction rating • Percent of toll transactions collected electronically • MVA branch office customer visit time versus customer satisfaction rating • Maryland driver satisfaction rating
Safety and Security	• Number of pedestrian fatalities and injuries on all Maryland roads • Annual number of traffic fatalities and personal injuries on all roads in Maryland
System Preservation and Performance	• Operating cost per MTA passenger trip • MVA cost per transaction • Percent of roadway miles with acceptable ride quality • Number of bridges and percent that are structurally deficient
Environmental Stewardship	• Transportation-related emissions by region
Connectivity for Daily Life	• *Annual number of air passengers at BWI Marshall Airport* • Port of Baltimore foreign cargo and MPA general cargo tonnage • *Annual transit riders on Maryland portion of Washington Metropolitan Area Transit Authority and MTA service.* • Percentage of State-owned roadway directional miles within urban areas that have sidewalks and percent of sidewalks that meet ADA compliance • Percent of freeway lane-miles and arterial lane-miles with average annual volumes at or above congested levels

4.3.1.3 Summary

The MTP establishes the agency's goals and uses a flexible approach for the development of the specific performance measures and sets of performance measures to be used. The ensuing performance reports are responsible for establishing and aligning the specific sets of measures. This approach allows the agency to adopt innovative measures or adjust the existing performance measures from year to year. In addition, because of this approach, both sets of performance measures in use at MDOT are strategically aligned with the agency's goals. Although the MTP establishes objectives for each of the agency's goals, both sets of performance measures used by MDOT are

directly linked with the goals established in the MTP without any linkage to the objectives.

4.3.2 Balanced

MDOT does not identify any of its measures as being input, output, or outcome measures. In addition, the ambiguous nature of applying the definitions of input, output, and outcome measures makes it difficult to classify an agency's set of measures individually. Therefore, the evaluation of the balance of MDOT's performance measurement program will examine the balance of each of the sets. The agency-wide set appears to contain a mixture of outcome and output measures, with some of each contained in all of the goal areas. The dashboard set does not seem to be as balanced as the agency-wide set. The dashboard set contains mostly outcome measures with only a couple of measures that appear to be output measures.

4.3.3 Manageable

Maryland has a large set of performance measures it reports in the Attainment Report, and a smaller, modified set of performance measures used for their performance dashboard. The extensive set used for the Attainment Report contains 48 measures, a large amount of measures to track at the strategic level. Large sets of performance measures like this can be time-intensive and resource-intensive and have the potential to overwhelm an agency. MDOT is able to manage this large set of measures, however, because ownership and responsibility for each of the performance measures is delegated to one or more of MDOT's numerous modal administrations. Even though MDOT is able to track all 48 of these measures through its modal administrations, for agency officials

and transportation planners this could be an overwhelming number of measures to comprehend.

Fortunately, MDOT also has a trimmed down set of measures for the performance dashboard, which is most likely used for agency transparency and accountability with the public. The dashboard set of measures contains only 18 performance measures, which is much more manageable and comprehendible than the full set of measures in the Attainment Report. Additionally, all but three of the measures used in the performance dashboard are adopted from the measures in the Attainment Report, so a minimal amount of agency effort is put into gathering data and calculating results for the dashboard measures.

4.3.4 Calculable

All of the performance measures included in MDOT's two sets of performance measures, except for the transportation-related greenhouse gas emissions are calculable. Additionally, the majority of these calculable measures have been repeatedly calculated to produce performance trend information. There are a few examples, however, where historical data was not reported by MDOT. For example, past data was not provided for the number of repeat discrepancies in the annual FAA regulation inspection, MPA compliance with the Maritime Security Act of 2002, percent of Homeland Security REAL ID Act benchmarks achieved, the statewide park-and-ride facility total spaces and average weekday utilization, and the daily reduction in vehicle trips and VMT from emissions reductions programs. For the rest of the performance measures that included historical performance data, performance levels were charted on bar and line graphs similar to the charts presented below in the communicable section. While past

performance data exists for the vast majority of MDOT's measures, no evidence from the statewide planning documents or performance measurement documents suggests that MDOT is actively forecasting future performance levels for its established strategic performance measures based on, for example, future funding scenarios.

4.3.5 Communicable

MDOT utilizes two different media for the reporting of performance: the Attainment Report and a performance dashboard that summarizes the Attainment Report. The Attainment Report, which is released annually, is an electronic document posted on the MDOT website that contains detailed performance information. The performance dashboard is an interactive webpage that is also posted on the agency's website, which provides a condensed glance at the performance information. These two media will be discussed in further detail in the following sections.

4.3.5.1 Attainment Report

The Attainment report is a 54-page long document that is composed of chapters organized by the agency's goals. Each of the chapters begins with an introductory page that provides an overview of the goal the chapter addresses. This introductory page includes a list of the objectives aligned with the goal, a description of what the goal means, the importance of the goal to the state, and MDOT's efforts in attaining the goal, a list of the key initiatives undertaken by MDOT and its modal administrations, and a list of the performance measures used to track MDOT's progress in meeting the goal (56). Figure 19 shows an example of an introductory page, the introductory page for the quality of service goal.

GOAL:

Quality of Service

Objectives

- Enhance customer experience and service
- Provide reliable and predictable travel time across modal options for people and goods
- Facilitate coordination and collaboration with agency partners and stakeholders

For people living in, traveling through, and doing business in Maryland, quality of service means access to transportation infrastructure and services that help them reach their travel destinations conveniently, comfortably and on time. Quality of service is important to Marylanders, as a reliable, well-maintained and efficiently-operated transportation system contributes to a strong economy and a high quality of life by reducing delay, offering diverse transportation options, and providing up-to-date information about the Maryland transportation system.

To deliver the quality of service that Marylanders expect, MDOT and its modal agencies keep pace with the age of instant information and information technologies by offering many real-time information services to assist travelers in planning where and when to travel and by what mode. These essential information services include initiatives such as the Maryland 511 traveler information system that encourages travelers to "Know Before You Go." The system provides travel information via the web or phone on State-maintained roadways, including travel time, incident or work zone lane closures weather reports, and connections to transit, airport, and tourism information. SHA also provides motorist information signs along highways to alert drivers to real-time travel conditions. The MTA works to improve the timeliness of transit service as well as transit information – several of MTA's transit rider services and tools have been adapted to work seamlessly with mobile devices, including the MTA Trip Planner, Service Status, Service Alerts and ElevatorEscalator Outages. This year, MTA will test and implement its real time passenger information system. The MVA offers an ever-increasing number of online MVA services, including online State Identification (ID) card renewal.

Quality of service also means providing the best value for each transportation investment. To achieve this end, MDOT applies a strategic decision making process and carefully selects transportation projects and invests in programs to ensure that public dollars are invested in an efficient and cost effective manner.

Key Initiatives

MDOT: Continue coordination with other State agencies through the Governor's FastTrack Program to expedite mixed-use, Transit-Oriented Development (TOD) projects, such as the Pike and Rose TOD at White Flint Metrorail Station in Montgomery County.

MAA: Deliver a major terminal enhancement project at Baltimore/Washington International Thurgood Marshall Airport (BWI Marshall) to improve and modernize the BWI Marshall passenger terminal facility.

MPA: Expand cruise offerings at the Port of Baltimore, such as the newly renovated Royal Caribbean Grandeur of the Seas which will return back to the Port of Baltimore in 2013. The ship is currently undergoing a $48 million revitalization that will include many of the company's most innovative features that are available on its two largest class ships.

MTA: Continue expanding the use of Automatic Vehicle Locator (AVL) technology to provide MTA's customers with real time arrival information and assist MTA in better monitoring on time performance.

MDTA: Through an innovative Public Private Partnership (P3) agreement, reconstruction and improvements have begun to the two aging travel plazas (the Maryland and Chesapeake Houses) along I-95 in northeast Maryland. Project estimated completion, summer 2014.

MVA: Continue to improve online services, such as MVA's FastTrack Licensing, that allows Marylanders to quickly and easily conduct a number of motor vehicle services for all vehicles that are associated with a driver's license number.

SHA: Continue to enhance the accuracy and timeliness of traveler information through "My 511 Direct" traveler services and the Coordinated Highways Action Response Team (CHART) website.

Performance Measures

MONITORING AGENCY	PERFORMANCE MEASURE	PAGE
MAA	Percent of BWI Marshall customers rating the airport "good" or "excellent" on key services	17
MPA	Average truck turn-around time at Seagirt Marine Terminal	17
MTA	Percent of service provided on time	15
MTA	Customer satisfaction rating	16
MDTA	Overall customer satisfaction of E-ZPass® customers	18
MDTA	Percent of toll transactions collected electronically	18
MVA	Branch office customer visit time versus customer satisfaction rating	16
SHA	Maryland driver satisfaction rating	14
SHA	Percentage of the Maryland SHA network in overall preferred maintenance condition	14

Figure 19: Example Introductory Page for Quality of Service in MDOT's Attainment Report (56)

In the following pages of each of the chapters, detailed performance information is provided for each of the performance measures included in the list on the introductory page. The detailed performance information includes an explanation of the particular

performance measure, reasons for why the agency's level of performance changed from the previous year, and future strategies for improving the agency's performance. For nearly all of the measures, historic data from previous years is included with the current level of performance to show trends in the agency's performance. Additionally, most of the measures include graphs that show the past performance levels and the agency's target to show whether the agency is meeting the established goals (56). Figure 20 shows an example of the detailed performance information, the detailed performance information for the percentage of Maryland SHA network in overall preferred maintenance condition.

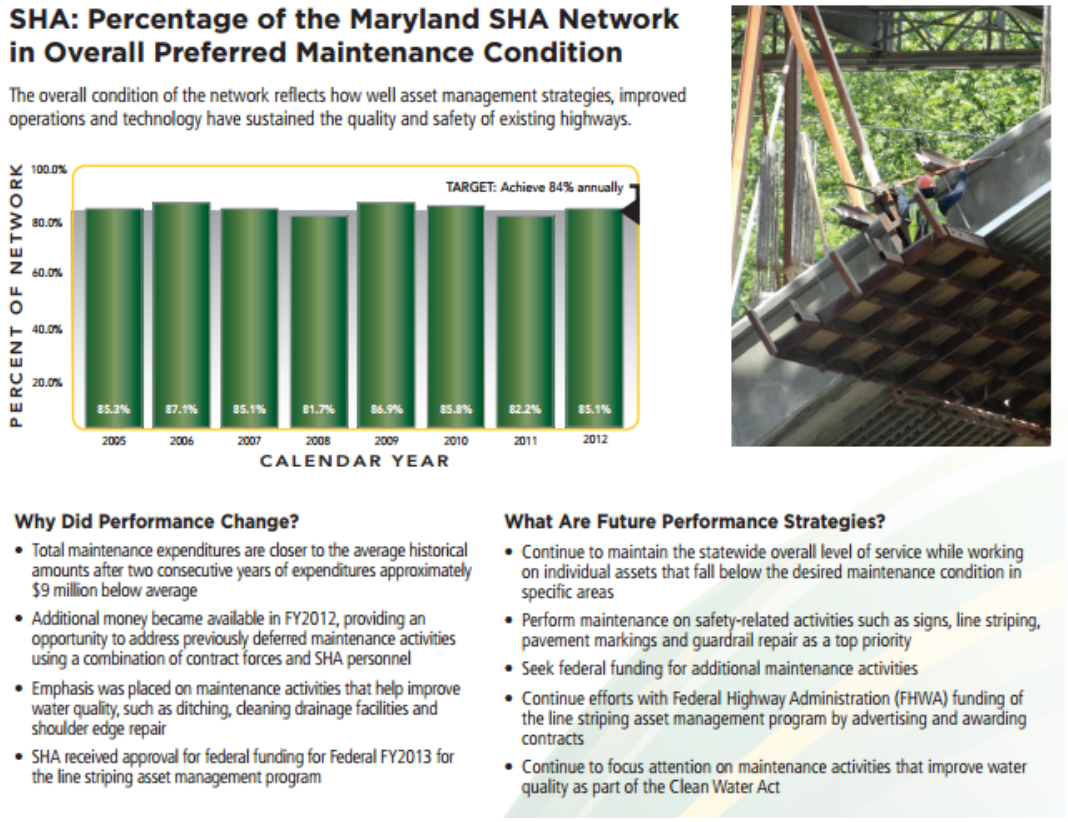


Figure 20: Example Detailed Information Page in MDOT's Attainment Report (56)

4.3.5.2 Performance Dashboard

The performance dashboard is an interactive webpage on the agency's website that provides the public with a concise version of the Attainment Report. Figure 21 shows the introduction page of the performance dashboard.

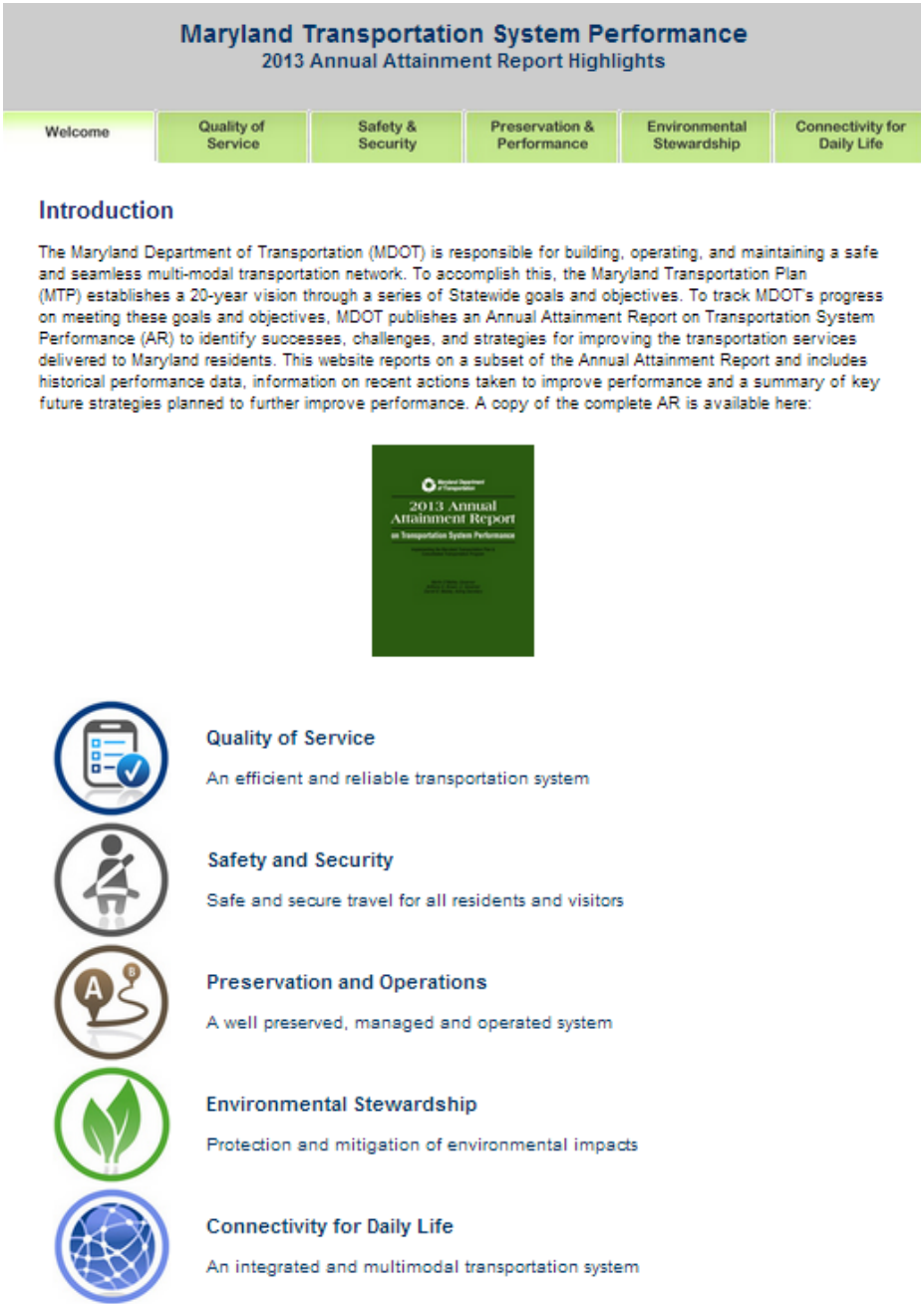


Figure 21: MDOT's Performance Dashboard Introductory Page (57)

The introduction page describes the purpose of MDOT's performance measurement program and gives additional information about each of MDOT's strategic goals. At the top of the performance dashboard, there are tabs for each of the agency's strategic goals, and more detailed performance information can be accessed by clicking on one of these tabs. Figure 22 shows a detailed performance information page for the goal ”connectivity for daily life”. Detailed performance information pages like this exist for each of the agency's goals (57).

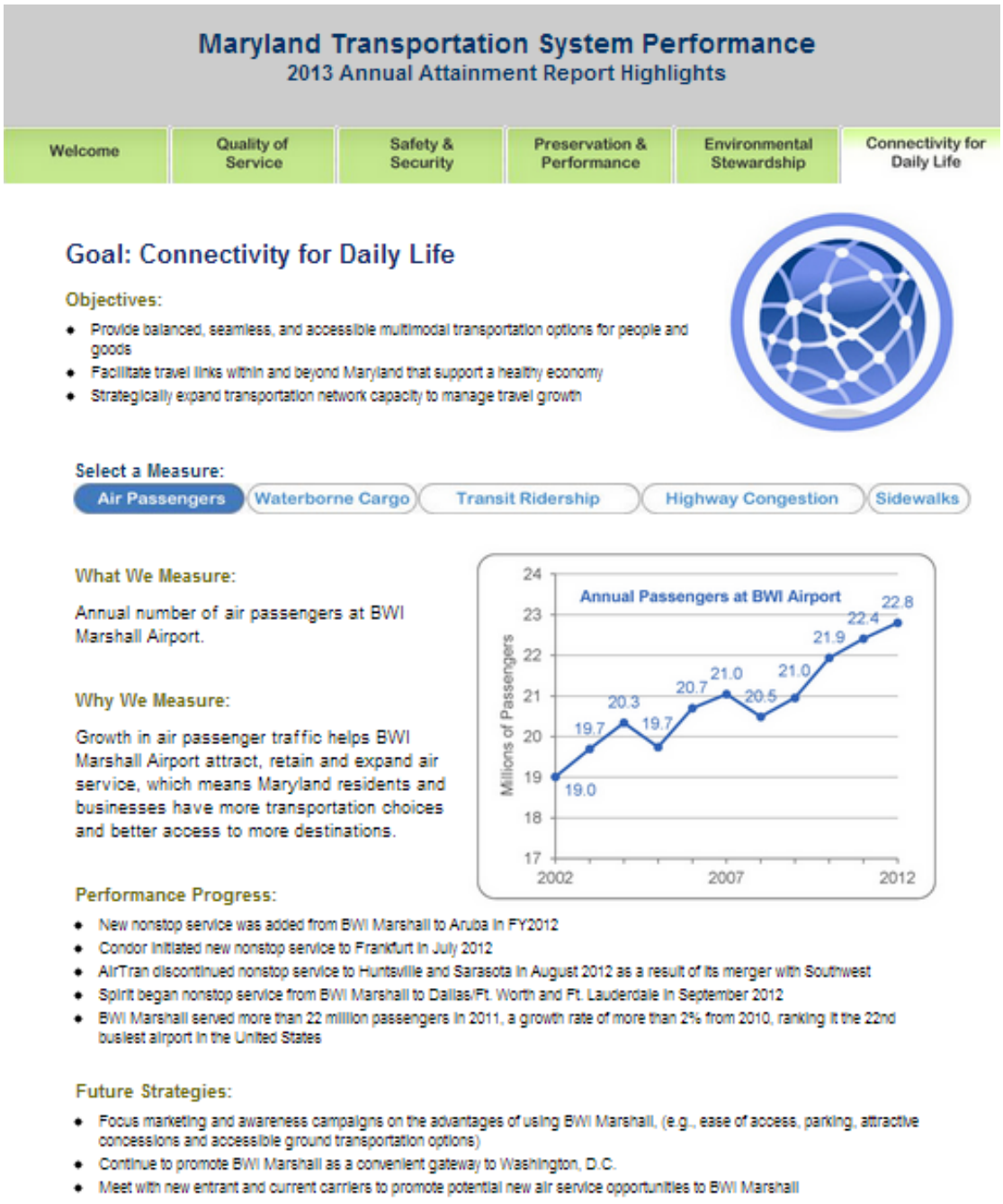


Figure 22 Example Detailed Performance Information Page on MDOT's Performance Dashboard (57)

For each of the goals, the detailed performance information pages provide a list of the objectives strategically aligned with the respective goals. Just under the list of objectives is a row of clickable tabs that relate to a subset of the performance measures

strategically aligned with the goal. When a tab is selected, the tab turns blue and information relating to the performance measures is displayed below the row of tabs. The information displayed relating to the performance measure includes the name of the measure, the reason for tracking the measure, key actions that have impacted the level of performance, and future strategies for improving performance for the particular measure. Additionally, a line graph showing the current and historic values of the performance measure is displayed to relay the current level of performance as well as the temporal trends in agency performance (57).

4.3.6 Multimodal

No evidence could be found to support the idea that MDOT uses a process or application to perform a multimodal tradeoff analysis to prioritize transportation investments across modes. However, the agency includes numerous measures that track the performance of non-highway modes in its sets of strategic performance measures. This practice gives decision makers a comprehensive view of the entire transportation system, non-highway modes included. The non-highway modes tracked in MDOT's sets of performance measures are the state's aviation facilities, bicycle and pedestrian networks, transit systems, cruise activities, and freight facilities.

The agency measures the performance of the state's aviation system through a number of measures. These include the percent of BWI Marshall customers rating the airport "good" or "excellent" on key services, the BWI Marshall crime rate, the number of repeat discrepancies in the annual FAA Federal Aviation Regulation inspection, the rate of airfield ramp incidents and accidents per 1,000 operations, the airline cost per emplaned passenger, the non-airline revenue per emplaned passenger, the number of

nonstop airline markets served, and the annual number of air passengers at BWI Marshall Airport. Performance of pedestrian and bicycle facilities is tracked by MDOT with the number of bicycle and pedestrian fatalities and injuries on all Maryland roads, the percentage of State-owned roadway directional miles within urban areas that have sidewalks, the percent of sidewalks that meet ADA compliance, the percentage of State-owned roadway centerline miles with a bicycle level of comfort grade "D" or better, and the directional mileage of SHA-owned highways with marked bike lanes. The state's transit system performance is also tracked through a number of measures. These include the percent of MTA service on time, the MTA customer satisfaction rating, customer perceptions of safety on the MTA system, the number of preventable accidents per 100,000 vehicle miles, the operating cost per passenger trip and per revenue vehicle mile, the number of passengers per revenue vehicle mile, the annual revenue vehicle miles of transit service provided, the average weekday transit ridership, and the annual transit riders on the Maryland portion of WMATA and MTA system. The cruise ship activity in Maryland is measured by the number of international cruises using the Port of Baltimore. Finally, the performance of freight facilities is measured through the average truck turn-around time at Seagirt Marine Terminal, MPA compliance with the Maritime Transportation Security Act of 2002, the dredge material placement capacity remaining for maintenance and new dredging, the revenue versus operating expense, and the Port of Baltimore foreign cargo and MPA general cargo tonnage.

4.4 Minnesota Department of Transportation

The statewide planning and performance measurement documents posted to the Minnesota Department of Transportation (MnDOT) website were used in the following

analysis. Included in these documents are the Minnesota Statewide Transportation Plan 2012-2031, the Minnesota Statewide Transportation Policy Plan, the Annual Minnesota Transportation Performance Report, the Minnesota 2011 Transportation Results Scorecard, and the interactive annual report, Explore Minnesota Transportation Performance.

4.4.1 Strategically Aligned

In September 2012, MnDOT adopted a new LRSTP, the Minnesota Statewide Transportation Plan 2012-2031, to serve as an update of the state's previous LRSTP, the Minnesota Statewide Transportation Policy Plan 2009-2028. In both of these plans, the agency's strategic goal areas are defined and specific performance measures are prescribed for each of the goals. However, as a part of the update to the LRSTP, the agency goals and performance measures were completely revamped, giving the agency a different set of goals and performance measures (58) (59).. Hence, while the newly adopted LRSTP contains a new set of agency goals and performance measures, the agency's most recent performance reporting documents still contain the agency goals and performance measures from the previous LRSTP (60) (61). In order to examine all aspects of MnDOT's performance measurement program, this case study will examine both of these, old and new, sets of agency goals and performance measures.

The previous LRSTP, the Minnesota Statewide Transportation Policy Plan 2009-2028, established ten goal areas: traveler safety, infrastructure preservation, maintenance, national and global connections, statewide connections, Twin Cities mobility, Greater Minnesota metropolitan and regional mobility, community development and transportation, energy and the environment, and accountability and transparency. The

plan provides background information, potential strategies, and an extensive list of performance measures for each of the goal areas. Even though the extensive lists of performance measures were provided in the previous LRSTP, a smaller and, in some cases, different set of the measures were actually tracked and discussed in the agency's performance reporting documents. In these latter documents, the performance measures that were tracked by the agency were clearly linked to the goals established in the LRSTP. Table 16, which shows the strategic alignment of MnDOT's previous set of goal and performance measures, was created from combining the goal areas identified in the old LRSTP with the performance measures reported in the agency's performance reporting documents. The left column lists the agency's goals and the right column contains the performance measures strategically aligned with each of the corresponding goals (58) (61).

Table 16: MnDOT's Previous Set of Goals and Performance Measures

Goal	Performance Measures
Traveler Safety	• Minnesota Traffic Fatalities (all state and local roads)
Infrastructure Preservation	• Bridge Condition: Percent good and satisfactory, state principal arterials • Bridge Condition: Percent poor, state principal arterials • Pavement: Ride quality poor, all state highways, percent of miles • Pavement: Ride quality poor, state principal arterials, % of miles • Pavement Ride quality good, state principal arterials, percent of miles
Maintenance	• Snow and Ice: Frequency of achieving bare lane within target hours, all storms and routes • Bridge Safety Inspections: Percent completed on time, all state bridges • Customer Satisfaction with State Maintenance: on a scale from 1 to 10
National and Global Connections	• Airline Annual Available Seat Miles from MSP on scheduled commercial flights • Port Shipments to and from MN Great Lakes and river ports: annual tonnage • Shipments on Minnesota Railroads: annual tonnage from, to, and through Minnesota
Statewide Connections	• Interregional Corridors: Greater MN, percent of miles +/- 2 mph of target speed or faster • Aviation Access: Percent of Minnesota population within 30 minute drive time of an airport with paved and lighted runway
Twin Cities Mobility	• Twin Cities Urban Freeway System Congestion: percent of miles below 45 mph in AM or PM peak • Clearance time for Metro Urban Freeway incidents: 3 year average • Annual Rail and Express Bus Transit Ridership: Express buses (all providers, light rail, commuter rail
Greater Minnesota Metropolitan and Regional Mobility	• Greater Minnesota Bus Service Hours: Public transportation
Community Development and Transportation	• ADA: Accessible Pedestrian Signals (APS), percent of state highway intersections with APS • Bike, Walk, and Transit Share of commuter trips: large Minnesota metro areas
Energy and the Environment	• Transportation Fuel Consumption: Billions of gallons sold in Minnesota
Accountability and Transparency	No measures tracked in performance reporting documents

In the most recent LRSTP, the Minnesota Statewide Transportation Plan 2012-2031, the agency's goal areas were narrowed to six: accountability, transparency, and communication, transportation in context, critical connections, asset management, traveler safety, and system security. The plan also includes a table depicting the agency's goal areas and the new set of aligned performance measures (59). Table 17 is an adapted version of this table showing the agency's goal areas and corresponding performance measures identified in the most recent LRSTP. The left column contains the updated agency goals and the right column contains the new performance measures that correspond to each of the respective goals. Given that no performance report has been published since the adoption of the new set of performance measures, it is unclear whether all of these measures will be reported by the agency on a regular basis. However, due to the relatively small number of measures, it is reasonable to expect all of these new measures to be included in the agency's performance reporting documents.

Table 17: MnDOT's New Set of Goals and Performance Measures

Goals	Performance Measures
Accountability, Transparency, and Communication	• Projects Let on Schedule, STIP Projects, Current Year: Percentage of projects in the first year of the STIP let in the planned year • Customer Satisfaction with Reliability of MnDOT Communications: Percentage of respondents to the Omnibus survey that rate the reliability of MnDOT Communications
Transportation in Context	• Airport Airspace and Land that is Protected: Percentage of publicly funded Minnesota airports that have Airport Safety Zoning • Compliance with Criteria Air Pollutant Standards: Federal compliance standards. Outdoor levels of ozone, nitrogen dioxide, carbon monoxide, and particulate matter • MnDOT Use of Cleaner Fuels: Gallons of fuel (with the percent ethanol subtracted) purchased for use in MnDOT on-road vehicles
Critical Connections	• Travel Speed on Greater Minnesota Interregional Corridors (IRC): Percentage of Greater Minnesota Interregional

	Corridor miles meeting or close to target speed • Access to Scheduled Air Service: Percentage of Minnesota's population within 60 minutes of an airport with scheduled airline service • Travel Time Index (TTI) and National Ranking: Ratio of peak to free-flow travel time • Transit Ridership: Passengers served in the Twin Cities Region • Greater Minnesota Public Transit Bus Service Hours: Total number of public transit bus service hours provided compared to the total number of hours needed to meet transit demand • Greater Minnesota Transit Coverage: Number of Greater Minnesota counties with countywide transit service
Asset Management	• Structural Condition of State Highway Bridges: National Bridge Inventory (NBI) Structural Condition Index • Ride Quality Index (RQI) for State Highway Pavements: Ride Quality Index • Bridge Inspection: On time routine and fracture critical bridge inspections • Snow and Ice Removal: Frequency of achieving bare lane within targeted number of hours
Traveler Safety	• Fatalities on All Roads: Annual vehicle-related fatalities on all state and local roads • General Aviation Fatalities: Annual fatalities resulting from general aviation crashes in Minnesota
System Security	• Traffic Signal, Lighting and ITS Maintenance (developmental) • Road Drainage Infrastructure Maintenance and Repair (developmental): Tracking of maintenance and repair of highest priority condition for (very poor condition) cross culverts - pipes that go underneath roadways

For both the old and new sets, the performance measures used are clearly and directly (without the use of objectives) aligned with the agency goals. For the new set of measures, the updated LRSTP defines the new agency goals and prescribes a set of performance measures that are strategically aligned with the goals. Given that a performance report has not been published since the adoption of the new set of performance measures, there is no evidence to determine whether the measures reported

will be the same as those identified in the LRSTP or if the reported measures will be strategically aligned.

For the old set of measures, the agency goals are defined in the old LRSTP and extensive lists of measures are provided for each of the goals. However, in the performance reporting documents created by MnDOT, the set of performance measures being reported is considerably smaller and different from the set prescribed in the old LRSTP. Evidently, MnDOT, at some point, adopted a flexible approach in allowing the set of performance measures being reported to change from the set of performance measures prescribed in the LRSTP. Although the set of performance measures in the performance reporting documents maintain a strategic alignment with the goals outlined in the LRSTP, the differences with the performance measures prescribed in the LRSTP could potentially be confusing.

4.4.2 Balanced

MnDOT does not classify its performance measures as input, output, or outcome measures. Given the ambiguity of applying the definitions of input, output, and outcome measures to individual performance measures, the balance of MnDOT's performance measurement program will be broadly examined at the set level.

Both the old and new sets of measures solely include output and outcome measures. The old set seems to include mostly outcome measures while the new set appears to contain an equal share of each. Although neither set contains input measures, the agency includes input measures for each of the agency-wide performance measures in one of its performance reporting documents. As will be discussed later in the ”communicable” measures section, MnDOT publishes an Annual Performance Report

that provides detailed performance information for each of its agency-wide performance measures. In addition to the data for the agency-wide performance measures, the detailed performance information includes the data relating to the agency resources committed to improving performance for the measure, what has been identified in the literature as an input measure. For instance, in the section reporting on traffic fatalities, the amount of money MnDOT has planned for safety investments in the STIP is also reported. In the section that reports the pavement condition performance, the amount of spending on pavement preservation is also reported. While whether the measures included in the set of agency-wide measures are output versus outcome is a matter of perspective, the inclusion of these input measures is clear. The inclusion of these input measures with the output/outcome measures is an effective practice because it allows decision-makers to infer a relationship between the commitment of agency resources to a program and the output or outcome of the program. This allows the decision-makers to weigh the importance of changes in funding for each of the programs and to gauge the efficiency or effectiveness of the program.

4.4.3 Manageable

While this case study examines two sets of performance measures for MnDOT, it should be emphasized that this is done so that all aspects of the performance measurement program can be examined during the transition from the old set of measures to the new set of measures. At any one point in time, MnDOT tracks only one set of performance measures at the strategic level. This practice of using only one set of measures makes the performance measurement program at MnDOT manageable for the agency and understandable for the public. Additionally, the number of performance

measures within MnDOT's sets of performance measures, both old and new, is manageable. The old set of measures contains 21 performance measures and the new set contains 19 performance measures. For each of the sets, the number of performance measures included us appropriate for a number of intended audiences. There are not too many measures to where the set is overwhelming for the public and decision makers to comprehend and there are just enough that the set of measures provides meaningful insight into the transportation system performance for technicians.

4.4.4 Calculable

Given that the performance reports for the new set of performance measures have yet to be released, there is not enough information to determine whether the new performance measures can be calculated, calculated repeatedly, or forecasted for future funding scenarios. As a result, the focus of this section will be on the old set of performance measures.

Each of the old performance measures are quantifiable and have been repeatedly calculated on an annual basis in the performance report and on the performance dashboard. In fact, on the performance dashboard, all but two of the measures have data for the last five annual measurements. The two that do not, the performance measures for interregional corridors and ADA accessibility, have performance data for the past three and four years, respectively. The past performance data is even more robust in the performance reports, with some performance measures having data tracing back to 2000.

While MnDOT has solid historical data for all of the old performance measures, the ability to forecast future performance levels has not been developed by MnDOT for the majority of the old performance measures. MnDOT does include projections for the

agency's performance in the measures relating to bridge condition, pavement condition, interregional corridors, and bus service hours. However, no evidence was found to suggest that MnDOT has the ability to project future performance for any of the other measures.

Despite MnDOT's limited success with projecting future performance levels, the agency does an exceptional job in calculating and tracking performance levels over time. Whether or not the agency can maintain this while introducing a new set of performance measures is a valid concern. First, both of the performance measures aligned with the goal of system security are identified as being developmental, which suggests that MnDOT has not been able to quantify them yet. Secondly, MnDOT most likely does not have the past performance data for the new set of measures that it does for the old set of measures. This would limit MnDOT's ability to understand trends in performance and develop projections for future performance levels. These are issues MnDOT will have to address in rolling out its new set of measures to sustain the effectiveness of its performance measurement program.

4.4.5 Communicable

MnDOT reports its performance through three media: the transportation results scorecard, the annual performance report, and the interactive report. Given that the performance measurement program at MnDOT is still in a state of transition in that the new performance reporting documents have not been produced since the new LRSTP and performance measures were adopted, the focus in this section will be solely on the previous set of performance measures and reporting media from the previous LRSTP. In the following sections, each of these media will be described in detail.

4.4.5.1 Transportation Results Scorecard

The transportation results scorecard is released annually and provides a brief two-page snapshot of the agency's performance. The scorecard contains all of the performance measures from Table 16 and organizes them based on the agency goal they are aligned with. Figure 23 shows the first page of MnDOT's transportation results scorecard as an example. The first column of the scorecard contains the name of the performance measure while the second column shows a graphic indication of the agency's performance. The graphic indicators used are a green circle, a yellow triangle, and a red hexagon. These indicators are used for performance measures that are at or above the target, moderately below the target, and seriously below the target, respectively. The third column presents the numeric result of the performance measure and the fourth column presents the numeric value of the target established for the performance measure. The fifth column in the scorecard displays a line graph with the past five years of collected data to explain any trends. Finally, the sixth column contains further explanation and analysis of the results of the performance measures. This scorecard is concise and information-rich and appears to be an effective tool for providing decision makers in the agency and in the state legislature with MnDOT performance information (60).

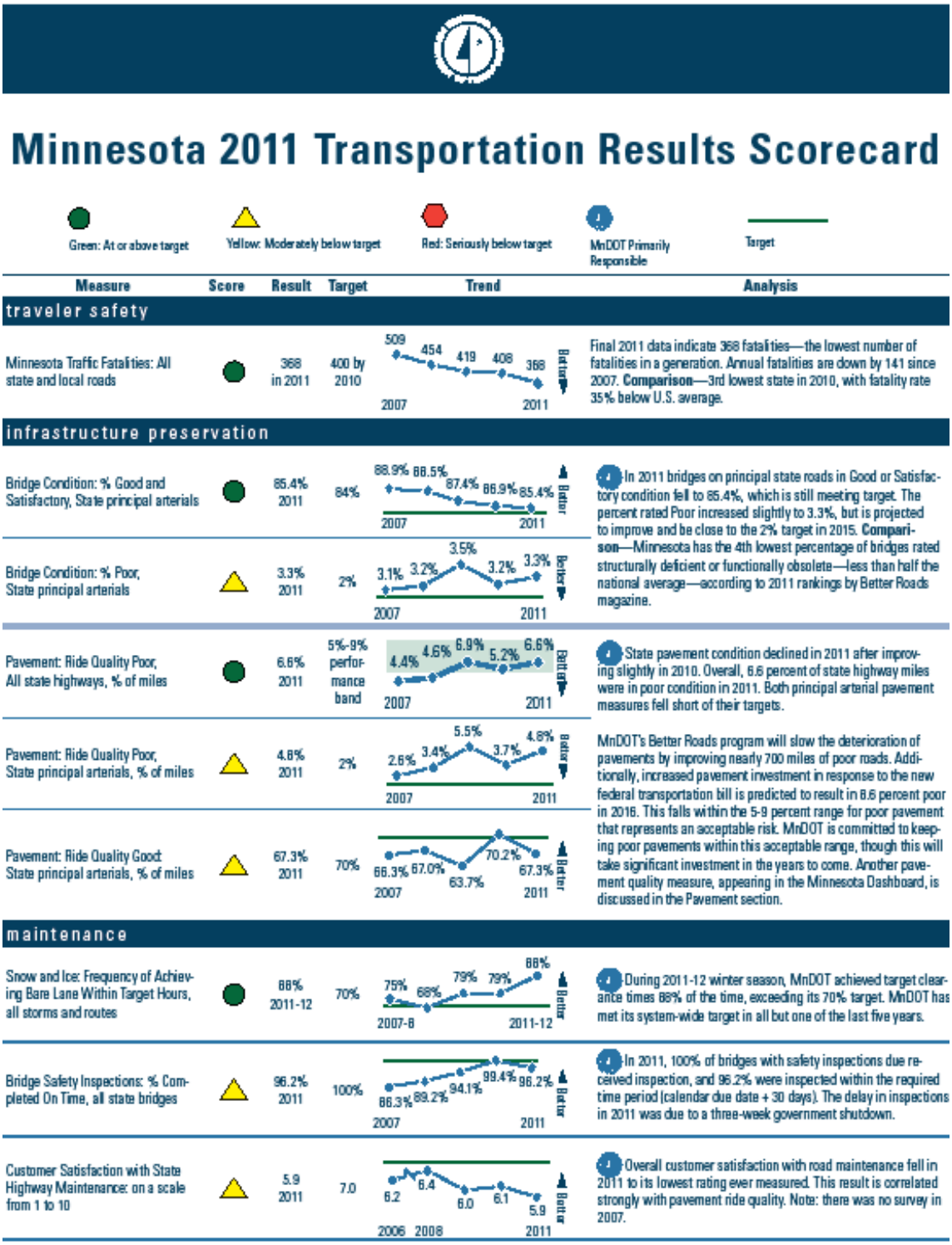


Figure 23: MnDOT's 2011 Transportation Results Scorecard (60)

4.4.5.2 Annual Performance Report

The annual performance report is also released every year and is a longer, more detailed performance reporting document than the transportation results scorecard. The annual performance report actually contains the transportation results scorecard as well as two pages of detailed information for each of the performance measures included in the transportation results scorecard. Figure 24 shows an example of these detailed performance information pages for, the performance measure, traffic fatalities in the 2011 Annual Performance Report. The detailed performance information includes a discussion of the agency's progress towards meeting the goals, the current agency efforts in improving performance, and how the performance information is used to drive agency decision making. The detailed performance information also includes bar graphs showing the performance measure results over time and, in most cases, includes a line graph showing the resources directed towards programs supporting the agency's performance in a particular measure over time (61).

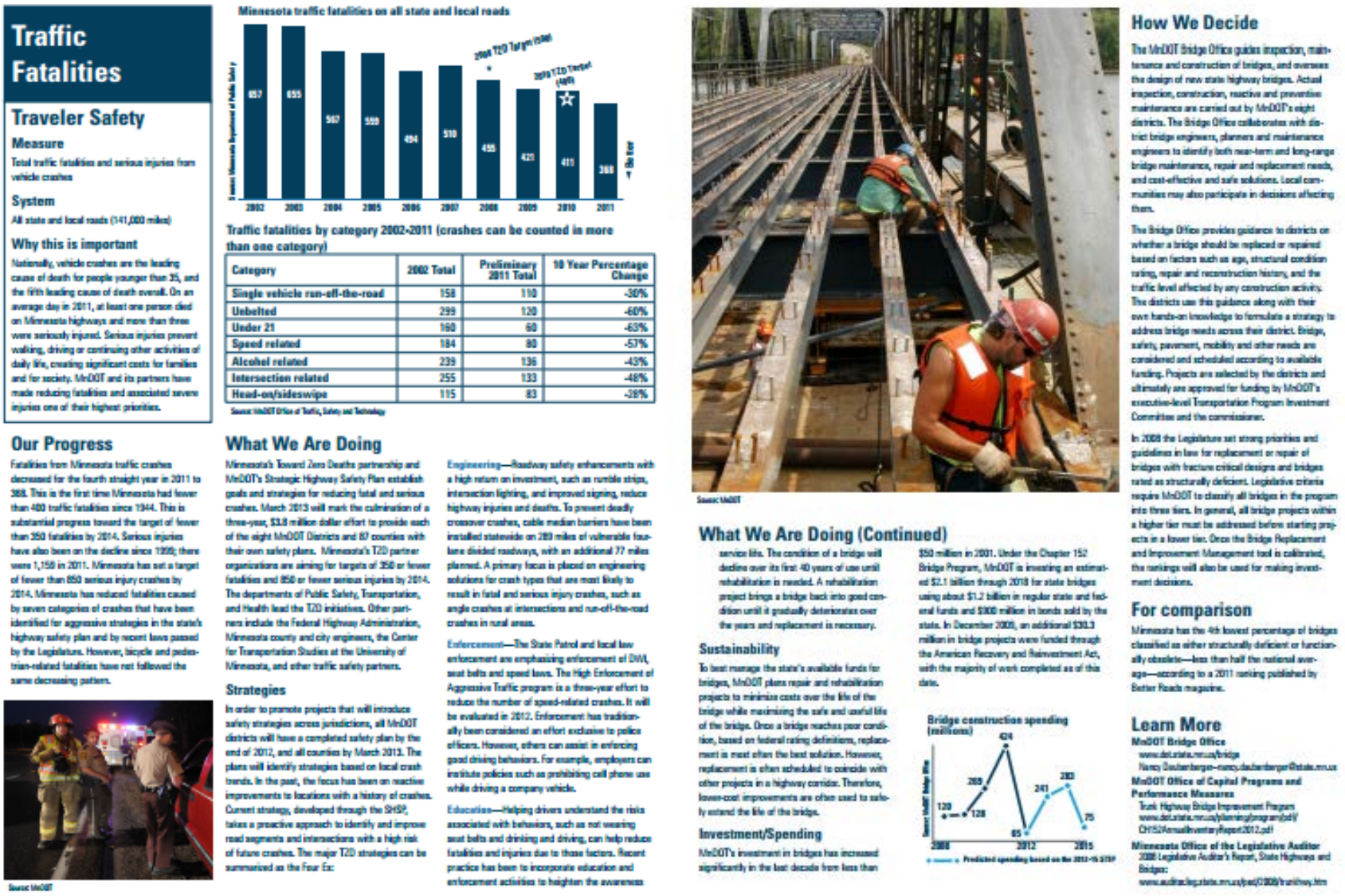


Figure 24: Example Detailed Performance Information Pages from MnDOT's Annual Performance Report (61)

4.4.5.3 Interactive Report

The interactive report was not developed in the most recent set of performance reporting documents; however, it was established each year for the two prior years. The interactive report is a document published on the agency's website that displays the performance information from the annual performance report in an interactive medium. The home screen of the interactive report, shown in Figure 25, contains a graphic depicting the agency's performance management cycle as well as clickable tabs along the sides of the screen for each of the performance measures included in the annual performance report (62).

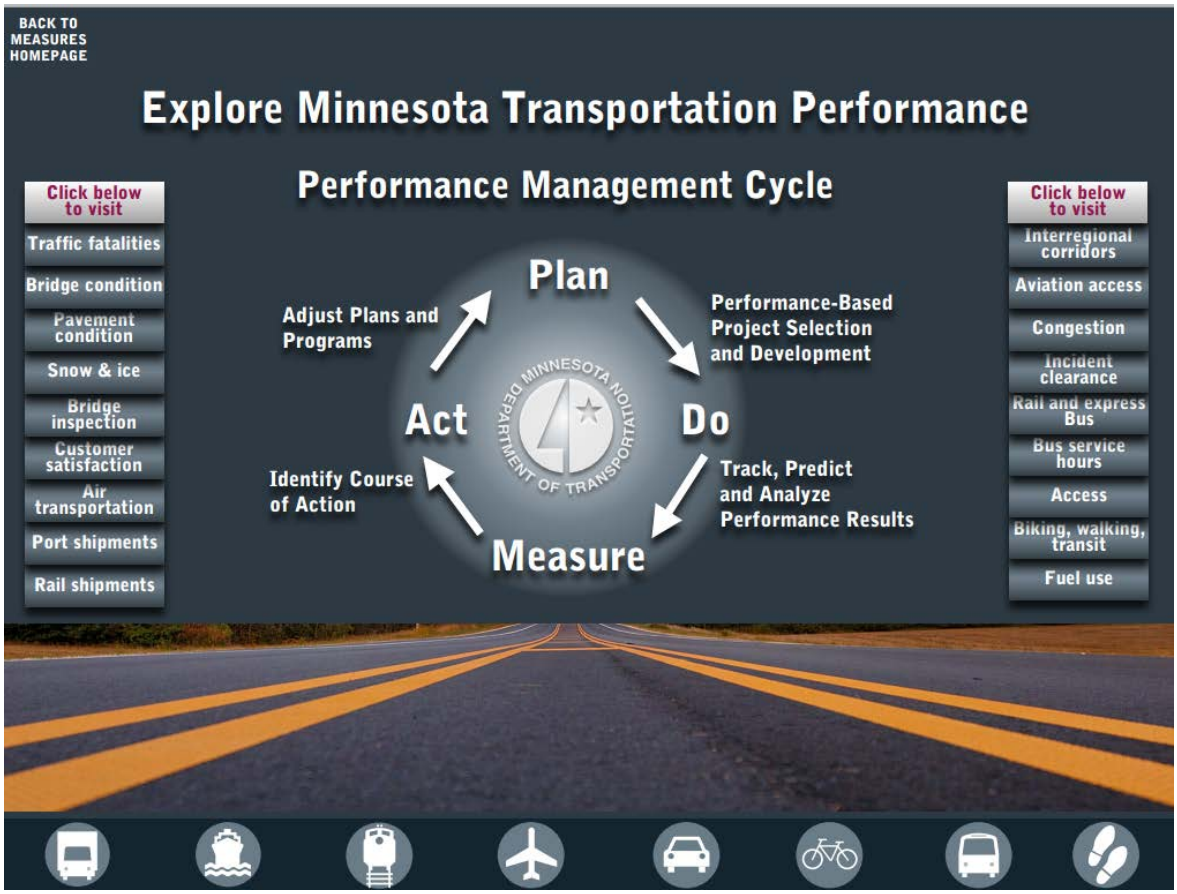


Figure 25: MnDOT's Interactive Report Home Screen (62)

Clicking on any of the measures brings up the detailed performance information for the particular measure. Figure 26Figure 25 shows an example of a detailed performance information page that can be accessed for each of the performance measures. Each of the detailed information pages contains an overview of the measure, a description of the agency's progress in meeting the target, and graphs displaying the results of the performance measurement over time. At the top of the page are three other tabs named "what we are going," "how we decide," and learn more. Clicking on these tabs will bring up information relating to current agency efforts and resources going toward improving the results of the performance measure, how the performance information is influencing agency decision making, and additional information, respectively (62).

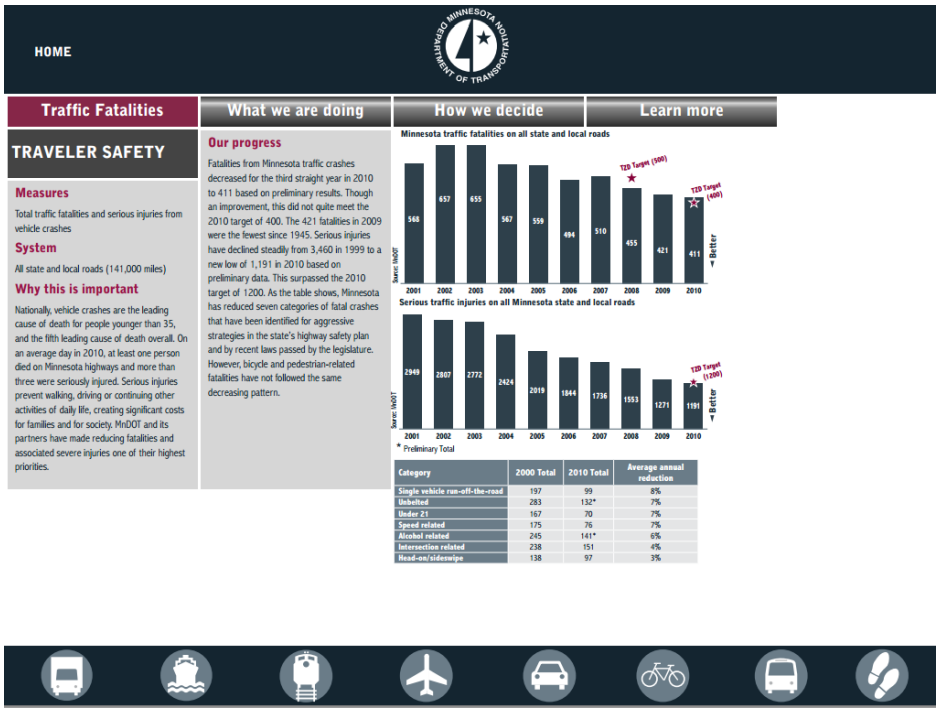


Figure 26: Example Detailed Performance Information Page from MnDOT's Interactive Report (62)

4.4.5.4 Summary

MnDOT's use of three performance reporting media allows the information to be presented in a different manner for different audiences. The transportation results scorecard allows decision makers to gain a succinct snapshot of the agency's performance, while the annual report provides more detailed information that places the agency's performance in the context of the current trends. The interactive report provides a medium that allows the user, whomever it may be, to customize the amount and type of information they can see.

4.4.6 Multimodal

Both old and new sets of performance measures developed by MnDOT are exceptionally modally inclusive. The old set of performance measures includes measures for a number of non-highway modes: passenger air travel, port freight, rail freight, transit, and bicycle/pedestrian. These non-highway measures are the annual available seat miles from MSP on scheduled commercial flights, the percentage of Minnesota's population with access (within 30 minutes drive time) to an airport with a paved and lighted runway, the annual tonnage of port shipments to and from the Minnesota Great Lakes and river ports, the annual tonnage of shipments to, from, and through Minnesota on Minnesota railroads, the annual rail and express bus transit ridership, the Greater Minnesota bus service hours, and the bike, walk, and transit share of commuter trips in Minnesota's large metropolitan areas.

The new set of performance measures adopted by MnDOT includes a number of non-highway measures as well as a mode neutral measure. The lone mode neutral measure used by MnDOT in the new set is the state's compliance with criteria air

pollutant standards. The non-highway measures in the new set only cover passenger air travel and transit and fail to address freight transportation or non-motorized transportation like the old set. The modal measures that support passenger air travel and transit in the new set are the percentage of publicly funded Minnesota airports that have airport safety zoning, the percentage of Minnesota's population within 60 minutes of an airport with scheduled airline service, the transit ridership in the Twin Cities region, the total number of Greater Minnesota public transit bus service hours provided compared to the total number of hours needed to meet transit demand, the number of counties with countywide transit service, and the annual fatalities resulting from general aviation crashes in Minnesota. While both set of measures are clearly multimodal, the old set covers a greater number of transportation modes.

4.5 Washington Department of Transportation

The following case study on the Washington State Department of Transportation (WSDOT) is based on the statewide planning and performance measurement documents posted on the agency's website. This includes the Washington Transportation Plan 2030 (WTP 2030), the WSDOT 2011-2017 Strategic Plan, and the Gray Notebook, the agency's performance reporting document.

4.5.1 Strategically Aligned

The Washington State Legislature codified into law (RCW 47.04.280) a set of six policy goals to be used in activities relating to the management of the state's transportation system. These six goals are economic vitality, preservation, safety, mobility, environment, and stewardship. In accordance with this legislation, the WTP 2030 and the agency's strategic plan, the WSDOT 2011-2017 Strategic Plan, are both

organized around these prescribed goal areas. The longer-range and broader document of the two, the WTP 2030 includes background information, agency strategies, recommended actions for each of the goals, but does not prescribe objectives or performance measures. The agency's strategic plan, however, picks up where the WTP 2030 leaves off and identifies the specific objectives and performance measures aligned with each of the goals that will be used to track performance for the six-year range of the plan (63) (64). Table 18 shows a simplified table of the aligned goals, objectives, and performance measures identified in the agency's strategic plan. The left column of the table lists the agency's goals areas. The middle column contains the objectives, horizontally aligned with the goals they support. Finally, in the right column are the performance measures identified for each of the corresponding objectives.

Table 18: Goals, Objectives, and Performance Measures Identified in the WSDOT Strategic Plan

Goal	Objective	Performance Measure
Safety	1.1 Highway Safety	• Number of traffic fatalities, all roads • Rate of traffic fatalities per 100 million VMT, all roads • Percent reduction in collisions before and after state highway improvements • Number of fatal and serious injury collisions
	1.2 Ferries Safety	• Milestones for ferry safety improvements met
	1.3 Airport Safety	• Number of state-managed airports with no airspace obstacles
	1.4 Rail Safety	• Requirements for rail safety met
	1.5 Worker Safety	• Number of OSHA-recordable workplace injuries and illnesses • Worker compensation claims
	1.6 Bridge Risk Reduction	• Number of bridge seismic retrofit projects completed • Number of bridge seismic retrofit projects completed within the I-5 lifeline corridor • Number of bridge foundation scour

		retrofit projects completed
	1.7 System and Facility Security	• Completion of high priority hardening projects identified in vulnerability assessments
	1.8 Continuity of Operations and Emergency Management and Response	• Completion of high priority hardening projects identified in vulnerability assessments
Preservation	2.1 Highways and Bridges Maintenance	• Percent of state highway pavement in fair or better condition • Percent of state bridges in fair or better condition
	2.2 Highway Pavement Preservation	• Percent of targets met for state highways maintenance activities
	2.3 Bridge Preservation, Rehabilitation, and Replacement	• Percent of state bridges in fair or better condition • Major bridge replacement projects completed
	2.4 Ferry Vessel Maintenance and Preservation	• Percent of state ferry vessel life-cycle preservation activities completed (Category 1 and 2 Systems)
	2.5 Ferry Terminal Maintenance and Preservation	• Percent of state ferry terminals in fair or better condition
	2.6 Airport Runway Preservation	• Percent of airport runway surfaces in fair or better condition
	2.7 Local Pavement and Bridge Preservation	Measure to be determined
	2.8 Safety Rest Area Maintenance, Preservation, and Improvements	• Percent of rest areas in fair or better condition
	2.9 Traffic Operations Equipment	• Preservation and Upgrades Traffic operations equipment maintenance and preservation backlogs
	2.10 Facilities Maintenance and Preservation	• Percent of agency facilities in fair or better condition
	2.11 Legacy Computer Systems Preservation and Replacement	• Milestones met for legacy computer systems preservation and replacement
Mobility	3.1 Strategic Highway Capacity	• Completed mobility projects funded by 2003 and 2005 funding packages
	3.2 Traffic Management	• Reliable travel times • Hours of delay

		• Average clearance time for major incidents
	3.3 Traveler Information	• Travel and traffic website usage
	3.4 Variable Tolling	• Milestones met in variable tolling projects
	3.5 Demand Management	• Percent of signals meeting operational review schedule • Drive-alone rate
	3.6 Highways and Ferries Operations	• Percent of ferry trips on-time • Vehicle hours of delay on state highways
	3.7 Airport and Passenger Rail Capacity	• Percent of Amtrak Cascades trips on-time
	3.8 Non-Motorized Transportation	Measure to be developed
	3.9 Intercity, Rural and Special Needs Transportation	• Status of Regional Mobility Grant projects
Stewardship	5.1 Capital Project Management and Delivery	• Capital project delivery • Projects completed on-time and within budget
	5.2 Identify and Articulate System Needs	• Quantification of system funding needs
	5.3 Information Technology and Decision Support Systems	• Milestones met in improving information technology and decision support systems
	5.4 Accountability and Communications	• Publication of agency accountability and performance information
	5.5 Workforce	• Workforce training targets met
	5.6 Enterprise Risk Management	• Enterprise risk management maturity model ratings
	5.7 Planning and Prioritization	• Planning and prioritization milestones met
	5.8 Equitable Access and the Americans with Disability Act (ADA)	• ADA and other accessibility requirements met
	5.9 Tribal Relations	• Compliance with WSDOT Centennial Accord Plan
	5.10 Research and Knowledge Management	• Implementation of research projects
	5.11 Sustainable Transportation	Measure to be developed
	5.12 Administrative Efficiency and Consolidation of Services	• Planning and prioritization milestones met
Environment	4.1 Stormwater and Puget Sound	• Number of WSDOT stormwater treatment facilities retrofitted or constructed

		• Conformance of WSDOT projects and programs with environmental legal requirements
	4.2 Species and Habitat Protection	• Conformance of WSDOT projects and programs with environmental legal requirements • Fish passage barriers removed
	4.3 Cultural Resources	• Conformance of WSDOT projects and programs with environmental legal requirements • Milestones met in cultural resources program
	4.4 Ferries Environmental Management	• Milestones met in state ferries environmental management program
Economic Vitality	6.1 Freight Mobility	Measure to be developed
	6.2 Contracting and Purchasing	Measure to be developed
	6.3 Rural Economic Vitality	Measure to be developed
	6.4 Public-Private and Public-Public Partnerships	Measure to be developed
	6.5 Economic Vitality Planning	Measure to be developed

While the agency's strategic plan identifies this extensive list of performance measures to be used by the agency, this particular list of measures is not reported by the agency at the strategic level, most likely due to the overwhelming number of measures involved. Instead, the agency reports two smaller and slightly different sets of performance measures. These two sets of measures, termed the set of key performance measures and the set of dashboard performance measures, are discussed in detail in the following sections.

4.5.1.1 Key Performance Measures

The set of key performance measures is reported on a regular basis in WSDOT's quarterly performance reporting document, The Gray Notebook. Each edition of The Gray Notebook identifies this set of key measures and links each of them to the agency

goals they support (65). Table 19, which shows the aligned goals and performance measures in key performance measures set, was created from information in The Gray Notebook about the agency's regularly reported key performance measures. In the tables, the agency's goals are listed in the left column and the performance measures aligned with each of these goals are listed in the corresponding cells of the right column.

Table 19: Goals and Performance Measures in WSDOT's Set of Key Performance Measures

Goal	Performance Measure
Safety	• Number of traffic fatalities, all roads • Rate of traffic fatalities per 100 million VMT, all roads • Percent reduction in collisions before and after state highway improvements • Number of OSHA-recordable workplace injuries and illnesses
Preservation	• Percent of state highway pavement in fair or better condition • Percent of state bridges in fair or better condition • Percent of targets met for state highways maintenance activities • Percent of state ferry vessel life-cycle preservation activities completed (Category 1 and 2 Systems) • Percent of state ferry terminals in fair or better condition
Mobility	• Travel times and hours of delay on state highways • Reliable travel times on the most congested state highways around the Puget Sound area • Average clearance time for major incidents lasting more than 90 minutes on key highway segments • Percentage of commute trips while driving alone • Ferry ridership • Ferry reliability • Percent of ferry trips on time • Amtrak Cascades ridership • Percent of Amtrak Cascades trips on time
Stewardship	• Capital project delivery: on-time and within budget • Recovery Act-funded project reporting (Rail)
Environment	• Number of WSDOT stormwater treatment facilities retrofitted or constructed • Conformance of WSDOT projects and programs with environmental legal requirements • Number of fish passage barriers fixed and miles of stream habitat opened up • Number of vehicle miles traveled

	• *Transportation related greenhouse gas emissions (to be developed)*
Economic Vitality	• Gray Notebook report on Freight • Gray Notebook report on Rail Freight • Gray Notebook report on Transportation Economic Indicators

4.5.1.2 Dashboard Performance Measures

The other set of performance measures reported by WSDOT at the strategic level are the dashboard performance measures. The performance dashboard, as will be discussed in detail in the "communicable" section below, is included in the front of The Gray Notebook but includes a set of measures independent from the key performance measure set. Like the key performance measures, the dashboard measures are organized by and aligned with the goals established in the WTP 2030 (65). Table 20 shows the performance dashboard set of measures and how they are aligned with WSDOT's goals. As in Table 19, the goals are located in the left column and the aligned performance measures are listed in the corresponding cells in the right column.

Table 20: Goals and Performance Measures in WSDOT's Set of Dashboard Performance Measures

Goal	Performance Measure
Safety	• Number of traffic fatalities, all roads • Rate of traffic fatalities per 100 million VMT, all roads • Percent reduction in collisions before and after state highway improvements • Number of OSHA-recordable workplace injuries and illnesses
Preservation	• Percent of state highway pavement in fair or better condition • Percent of state bridges in fair or better condition
Mobility	• Annual vehicle hours of delay statewide at maximum throughput speeds • Average clearance time for major incidents lasting more than 90 minutes on key highway segments • Percent of ferry trips departing on time • Percent of Amtrak Cascades trips arriving on time
Stewardship	• Cumulative number of projects completed and percentage on time • Cumulative number of projects completed and percentage on budget

	• Variance of total project costs compared to budget expectations
Environment	• Number of WSDOT stormwater treatment facilities retrofitted or constructed • Number of fish passage barriers fixed and miles of stream habitat opened up
Economic Vitality	No measures reported

4.5.1.3 Summary

Each of the sets of performance measures used by WSDOT contains performance measures that are clearly linked to the strategic goals identified in the WTP 2030. While the set of measures identified in the strategic plan uses intermediary objectives to create three layers of alignment, both the key performance measures and the dashboard performance measures are directly linked to the agency goals without the use of intermediary objectives. WSDOT, like FDOT, NCDOT, and MDOT, did not prescribe performance measures in the WTP 2030. As discussed before, this allows for greater flexibility in the development of multiple sets of performance measures that are all strategically aligned with the agency's LRSTP and the goals established in it. However, WSDOT did prescribe performance measures in the strategic plan that is updated on a less frequent basis, so the performance measures identified in the strategic plan were not the same as the measures used in the key performance measure set or the dashboard performance measure set. Like MnDOT, there is the potential for some confusion caused by the discrepancy in the measures identified in the strategic plan and the measures included in the agency's sets of performance measures.

4.5.2 Balanced

WSDOT does not classify any of its measures as being input, output, or outcome measures. In addition, the ambiguous nature of applying the definitions of input, output,

and outcome measures makes it challenging to classify the agency's set of measures individually. Therefore, the analysis of the balance WSDOT's performance program will broadly examine the balance of measures in each of the sets. The key performance measure set appears to include both outcome and output performance measures. There are more outcome measures included in the set; however, the majority of the measures used for the goal areas of stewardship and environment appear to be output measures. The same is true of the dashboard performance measures. The outcome measures appear to outnumber the output measures, but the measures used for stewardship and environment are mostly output measures. The use of output measures for the stewardship goal area is understandable because this goal is closely related to organizational performance rather than system performance. The use of output measures for the goal of environment is less clear, but could be because outcome measures had not yet been developed for this goal area.

4.5.3 Manageable

WSDOT identifies three distinct sets of performance measures in its strategic, statewide planning and performance measurement documents and the number of performance measures included in these documents appears to be unmanageable. While the agency appears to be handling the large number of sets and measures, the amount of performance information is overwhelming for the public and decision-makers alike. There are multiple reasons why these sets of performance measures are overwhelming. First, unlike FDOT, who also has three sets of performance measures, WSDOT does not clearly differentiate between or explain the purposes of each of its sets of performance measures. Additionally, a large number of performance measures are identified in each of

the three sets. For example, there are 57performance measures identified in WSDOT's strategic plan. The set of key performance measures that are regularly reported in the Gray Notebook contains 25 measures and 3 economic vitality reports, and the set of measures used in the agency's dashboard contains 15 measures. While a few of these performance measures are used in multiple sets, the inconsistent manner in which they are named across sets is a potential source of confusion. Finally, the composition of the agency's performance reporting document, the Gray Notebook, provides a source of further complexity. Each edition of the Gray Notebook, released quarterly, contains detailed performance information for a different combination of the key performance measures. As a result, in order to view the performance information for all of the key performance measures, one has to examine four sequential editions of the Gray Notebook. In addition to this, the Gray Notebook also contains detailed performance information for measures that are not included in any of the sets of performance measures. The combination of these complexities is a potential source of confusion for the general public and decision makers.

4.5.4 Calculable

As described in the previous section, WSDOT tracks a large number of performance measures. For purposes of keeping this analysis concise, this section will only examine the agency's set of key performance measures in the Gray Notebook and the set of dashboard performance measures.

Within the set of key performance measures, the agency has not yet been able to measure transportation related greenhouse gases. The rest of the measures included in the set of key performance measures are calculated by the agency and seemingly calculated

on a regular basis over the 49 editions of the Gray Notebook. Despite this rich data of past performance, only a handful of the key measures presented in the Gray Notebook were presented with enough past data in order to show long-term trends. Additionally no evidence was found to indicate that WSDOT is using this past performance data to forecast future performance levels for any of the key performance measures.

WSDOT calculates each of the measures included in the set of dashboard performance measures. The one missing aspect in the dashboard set of measures is the lack of a performance measure for economic vitality. Despite this omission, WSDOT does an exceptional job of calculating the dashboard performance measures for the other goals, and calculating them in a repeatable manner. In each quarterly edition of the Gray Notebook, an updated version of the performance dashboard, with updated calculations, is included. The performance dashboard also includes the result of the performance calculations for the previous reporting period to show the short-term trend. No information was uncovered on WSDOT's use of its past data to forecast future performance levels for its dashboard performance measures.

4.5.5 Communicable

The Gray Notebook is WSDOT's main performance reporting document and is released quarterly. The first chapter of the document, the introduction, defines the agency's key performance measure set and presents the performance dashboard (which in comparison with other agencies appears to be more like a scorecard). In the introduction, the key performance measures are broken down by the policy goals they are aligned with and a table of aligned performance measures is presented for each of the policy goals. Figure 27 is an example of one of these tables used to present the key performance

measures, the table for the key safety performance measures. In these tables, the key performance measures are identified in the first column and the corresponding rows of the second and third columns contain the reporting cycles for the performance measures (quarterly, semi-annual, or annual) and the locations of the most recent results for the performance measures. The column displaying the location of the most recent result contains both The Gray Notebook edition number and the page number where the most recent result can be found.

Key WSDOT performance measures	Reporting cycle	Most recent *GNB* report
Number of traffic fatalities	annual	GNB 46, p. 4
Rate of traffic fatalities per 100 million miles traveled	annual	GNB 46, p. 4
Percent reduction in collisions before and after state highway improvements	annual	GNB 45, p. 5
Number of recordable workplace injuries and illnesses	quarterly	GNB 49, p. 3

Figure 27: Example of the Key Performance Measure Reporting Tables in The Gray Notebook (65)

The performance dashboard also groups the performance measures by the goals they are aligned with; however, all the goals are presented in the same page-long table in the performance dashboard. Figure 28 shows the performance dashboard reported in The Gray Notebook Edition 49. The first column in the performance dashboard contains the list of performance measures tracked in the dashboard. The next three columns contain the result from the previous reporting period, the result from the current reporting period, and the agency target (referred to by them as a goal), in that order from left to right. The next two columns contain graphic indicators showing whether the target had been met and showing the current trend of the measure. The column showing whether the target

had been met uses a gray check mark to indicate performance measures where the target had been met, a dash for performance measures where the target had not been met, and an "N/A" for measures that do not have targets. The column showing the current trend for the performance measures uses an upward pointing arrow to indicate measures trending in a favorable direction, a horizontal double-pointed arrow to indicate measures with no change, and a downward pointing arrow to indicated measures trending in an unfavorable direction. The final column of the performance dashboard contains any relevant comments for each of the performance measures (65).

WSDOT's Performance Dashboard

✓ Goal has been met. ↑ Performance is trending in a favorable direction. ↔ Trend is holding. ↓ Performance is trending in a unfavorable direction.

Policy goal/Performance measure	Previous reporting period	Current reporting period	Goal	Goal met	Progress	Comments
Safety						
Rate of traffic fatalities per 100 million vehicle miles traveled (VMT) statewide (Annual measure: calendar years 2010 & 2011)	0.80	0.80	1.00	✓	↔	The rate of highway fatalities held steady (a lower rate is better). But the total is the lowest since 1954.
Rates of **recordable incidents** and days away, restricted or transferred for every 100 WSDOT workers[1] (Cumulative year to date 2012 & 2013)	4.6/ 2.2	4.2/ 1.3	5.0/ N/A	✓/ N/A	↑	Both the rate of worker injuries and the incident rate requiring days away from work improved.
Preservation						
Percentage of state highway pavement in fair or better condition (Annual measure: calendar years 2010 & 2011)	92.0%	90.5%	90.0%	✓	↓	A 1.5 percent decrease from previous year. Pavement condition has been declining since 2008.
Percentage of state bridges in fair or better condition[2] (Annual measure: fiscal years 2011 & 2012)	95.0%	95.0%	97.0%	–	↔	Structural condition ratings criteria continue to be a challenge.
Mobility (Congestion Relief)						
Highways: annual (weekday) vehicle hours of delay statewide at maximum throughput speeds[3] (Annual measure: calendar years 2009 & 2011)	28.1 million	32.5 million	N/A	N/A	↓	Increase of 16 percent from 2009 to 2011, with 2009 being the least congested year in past five years.
Highways: Average clearance times for **major (90+ minute) incidents** on nine key western Washington corridors (Calendar quarterly measure: Q4 2012 & Q1 2013)	161 minutes	143 minutes	155 minutes	✓	↑	Average clearance time decreased for the quarter, and met the goal of 155 minutes.
Ferries: Percentage of trips departing on time[3] (Fiscal quarterly measure: year to year: Q3 FY2012 & Q3 FY2013)	96.3%	97.8%	95%	✓	↑	Performance is higher than the same quarter a year ago and exceeds the goal.
Rail: Percentage of Amtrak Cascades trips arriving on time[4] (Calendar quarterly measure: year to year Q1 2012 & Q1 2013)	68%	71%	80%	–	↑	On-time performance improved over the same quarter last year and did not meet the goal.
Environment						
Cumulative number of WSDOT **stormwater management facilities** constructed or retrofitted[5] since 1995 (Annual measure: calendar years 2010 & 2011)	Over 800	Over 1,037	N/A	N/A	↑	Stormwater facilities will now be constructed under a new permit, with new requirements.
Cumulative number of WSDOT **fish passage barrier improvements** constructed since 1990 (Annual measure: calendar years 2011 & 2012)	257	269	N/A	N/A	↑	Past reporting period number was corrected from 258 to 257.
Stewardship						
Cumulative number of Nickel and TPA projects **completed, and percentage on time**[6] (Calendar quarterly measure: Q4 2012 and Q1 2013)	341/ 88%	344/ 88%	90% on time	–	↔	Performance remained the same this quarter and did not meet goal by a small margin.
Cumulative number of Nickel and TPA projects **completed** and **percentage on budget**[6] (Calendar quarterly measure: Q4 2012 and Q1 2013)	341/ 91%	344/ 91%	90% on budget	✓	↑	Performance improved over last quarter and continued to meet the goal.
Variance of total project costs compared to budget **expectations**[6] (Calendar quarterly measure: Q4 2012 and Q1 2013)	under budget by 1.3%	under budget by 1.4%	on budget	✓	↔	Total Nickel and TPA construction program costs are within 1.4 percent of budget.

Figure 28: WSDOT's Performance Dashboard (65)

The remaining chapters of The Gray Notebook are organized around the agency's six policy goals. Each of the chapters contains quarterly updates, semi-annual reports, and/or annual reports based on the agency objectives identified in the strategic plan. These objective-based updates and reports contain the detailed performance information

for a number of performance measures. The performance measures included in the reports are loosely based off the aligned performance measures identified in the agency's strategic plan, but it is not exact. The updates and reports also include detailed information on the key performance measures that are due to be reported on, according to their reporting cycle. The performance measures presented in these updates and reports use a number of visualization techniques: bar graphs, line graphs, pie charts, tables, and maps. In addition, all of the performance measures are accompanied by text that provides context or explanation for the measures being presented (65). In addition to the full version of The Gray Notebook, WSDOT also publishes a shortened version called The Gray Notebook Lite that contains a handful of highlights and measures and the agency's performance dashboard.

WSDOT also reports on transportation system performance to the legislature through its biennial transportation attainment report. The biennial transportation attainment report contains a scorecard-like summary of its own as well as detailed performance information for each of the performance measures identified in the summary. The detailed performance information in this report is also represented through a number of graphical elements: bar graphs, line graphs, tables, and maps.

4.5.6 Multimodal

The set of key performance measures contains a number of mode neutral and non-highway measures. The mode neutral measures include the percentage of commute trips while driving alone (reduces all modes to trips) and the economic indicators in the report. The non-highway modes covered are ferries, intercity passenger rail, and freight transportation for rail facilities, airports, and seaports. The measures for the ferry system

include the state ferry vessel life-cycle preservation activities completed, the percentage of state ferry terminals in fair or better condition, the state's ferry ridership, the ferry system reliability, and the percentage of ferry trips on time. The two measures relaying intercity passenger rail performance are the Amtrak Cascades ridership and the percentage of Amtrak cascades trips on time. Performance information for the state's freight transportation system, particularly railroads, airports, and sea ports is included in the semi-annual report on rail freight and the annual report on freight.

The set of dashboard performance measures also contains performance information for the state's ferry and intercity passenger rail systems, but does not include information for the freight transportation system like the set of key performance measures. The measures used for the ferry and intercity passenger rail systems are the percentage of ferry trips departing on time and the percentage of Amtrak Cascades trips arriving on time, in that order.

Overall, WSDOT's performance measurement includes a number of modes besides the state's highway system. The ferry, intercity passenger rail, and freight transportation systems are all included in the strategic performance measure sets used by the state. Like many of the other states, however, WSDOT does not appear to be currently using these strategic performance measures to perform multimodal tradeoff analyses at the statewide level.

CHAPTER 5

CONCLUSIONS

A qualitative assessment was performed on the performance measurement programs at the state DOTs included in the five case studies. The assessment evaluated the state DOTs on each of the evaluation criteria identified in the literature separately. These evaluation criteria are: strategically aligned, balanced, manageable, calculable, communicable, and multimodal. Table 21, below, is the summary of the qualitative evaluation for each of the state DOTs in each of the evaluation criteria. The columns in the table correspond to the state DOTs and the rows to the evaluation criteria. Filled in circles represent the state DOTs that demonstrate best practice for the evaluation criteria. Half-filled circles indicate state DOTs that exhibit good practices. Unfilled circles identify states that could improve practices for the evaluation criteria. In the row for the multimodal criteria, there are six modes listed in italics: aviation, bike/pedestrian, cruise/ferry, intercity rail, transit, and freight (although freight is not a mode, it is separated out from passenger transportation in this analysis). The gray circles in each of the cells corresponding to these modes are filled if the agency tracks a performance measure relating to the mode and empty if the agency does not report a measure relating to the mode. There are two half-filled circles used in these rows, for MnDOT bike/pedestrian and freight. This is because measures for these modes were included in MnDOT's old set of measures but were not identified in the new set of measures to be used in the future. The following sections will include a summary of findings for each of the six evaluation criteria established in the literature review.

Table 21: Summary of Case Study Results

Criteria	FDOT	NCDOT	MDOT	MnDOT	WSDOT
Strategically Aligned	◒	●	●	○	◒
Balanced	◒	◒	◒	●	◒
Manageable	◒	●	◒	●	○
Calculable	◒	◒	◒	●	◒
Communicable	●	●	●	◒	◒
Multimodal	●	●	◒	◒	◒
Aviation	●	○	●	●	○
Bike/Pedestrian	●	○	●	◒	○
Cruise/Ferry	●	●	●	○	●
Intercity Rail	●	●	○	○	●
Transit	●	●	●	●	○
Freight	●	●	●	◒	●

5.1 Strategically Aligned

From the case studies, one major issue stood out as the most important, the approach to developing and strategically aligning performance measures. Most of the states used a flexible approach in the development and strategic alignment of their performance measurement programs. The flexible approach is characterized by identifying only goals and objectives in the LRSTP and developing the specific performance measures in more regularly updated documents. FDOT, NCDOT, and MDOT have all built this flexibility into their performance measurement programs. They have used performance reporting documents to identify the specific performance measures rather than prescribe specific performance measures in the LRSTPs. WSDOT also did not prescribe performance measures in its LRSTP; however, WSDOT prescribed a set of performance measures in the agency's strategic plan which is updated on a less frequent basis. Therefore, WSDOT does not have the same level of flexibility as the state DOTs that identified the measures in performance reporting documents. MnDOT, on the other hand, was the only state in the case studies that prescribed a set of performance measures in their LRSTP and some drawbacks to this approach were evidenced in MnDOT's performance measurement program.

The two major advantages of using a flexible approach to performance measure development and strategic alignment are that it allows the agency to develop multiple sets of measures and that it allows the agency to change the particular measures in between plan updates. All the state DOTs in the case study but MnDOT have developed multiple sets of performance measures for multiple audiences. The literature pointed out that the increased demands for transparency and accountability would require a flexible

framework to foster communication of performance to diverse audiences. Given this, creating multiple sets of performance measures will be pivotal for state DOTs to meet the political pressures being placed on the modern state DOT.

The other major advantage of a flexible approach to performance measure development and strategic alignment is the ability to change the performance measures being used between plan updates. This is important because the ability to add new and innovative performance measures as well as the ability to take out ineffective performance measures is critical to maintaining a successful performance measurement program. State DOTs that do not use a flexible approach are faced with a difficult tradeoff when considering a change to their performance measure sets. When changes are made to the performance measure set, inconsistency between the agency's performance documents and planning documents results. Therefore, state DOTs must decide between using the best possible and most currently relevant set of measures or having consistent agency documents. Both states, MnDOT and WSDOT, that prescribed specific performance measures in statewide planning documents chose to have the best possible set of measures and made changes to the performance measure sets included in the planning documents. This approach creates inconsistency in the agency's documents, which could be a source of confusion for consumers of the performance information.

Two other minor innovations stood out in the case studies. The first was the exclusion of objectives from the strategic alignment of strategic performance measures at state DOTs. Each of the DOTs studied in this thesis, with the exception of FDOT, did not include objectives in the alignment of their performance measures. The performance measures used were directly tied to strategic goals. While this is not the standard practice

identified in the literature, it appears to be equally as effective. In fact, there may be a benefit to cutting out objectives from the strategic alignment. Typically, there are multiple objectives per goal area and multiple performance measures per objective, so cutting out a layer of alignment may reduce the number of measures used by an agency, making the program more manageable. Again, this is a judgment issue.

The second innovation identified in the case study was from NCDOT's Annual Performance Report. Each year the report provides the results for the executive performance measures used in the previous year and identifies the executive performance measures to be used in the next year. This practice is effective because it provides an easily traceable history of the changes in the performance measure set from year to year.

5.2 Balanced

None of the states classified their strategic performance measures as input, output, or outcome measures. The analysis for each of the state DOTs broadly examined the balance of each of the sets of measures used by the agencies due to the ambiguous nature of classifying an individual measure as input, output, or outcome. Nearly all the measures in use at a strategic level at the five state DOTs appear to be either output or outcome; input measures are not widely used in strategic performance measurement sets. In addition, outcome measures were more prevalent than output measures, particularly for goal areas relating to system performance and condition. Output measures appeared to be more popular for goal areas that related to organizational performance. The state with the most innovation with respect to balance was Minnesota. MnDOT actually presents their set of performance measures (all output or outcome) with additional measures of input, typically the level of funding committed to the program area. This practice allows

decision-makers to track how the performance output or outcome changes in relation to change in input, which provides for a greater understanding of how an increased or decreased allocation of resources will impact the program performance. State DOTs should include input measures with the output or outcome measures to link the levels of input to the performance output or outcome.

5.3 Manageable

There are two considerations in determining the manageability of an agency's performance measurement program. One consideration is the ability of the agency to track all of the measures included in their performance measurement program in a cost-efficient manner. The other consideration is the ability of the consumers of performance information to comprehend the agency's performance from the performance information. In both of these considerations, it is important to keep the number of sets and the number of measures included in the sets concise and meaningful.

From the case studies, four of the five state DOTs have multiple sets of performance measures. FDOT and WSDOT have three and NCDOT and MDOT have two. While there are benefits to having multiple sets of performance measures, as noted above in the section on strategic alignment, there is also a tradeoff to having multiple sets in terms of manageability. Multiple sets of performance measures are much more manageable for the public if the purposes of each of the sets are made apparent. For instance, both FDOT and WSDOT identify three sets of performance measures. FDOT has one set of measures that is specified for the SIS, one set of measures for public accountability and transparency (dashboard performance measures), and one set for strategic planning purposes (agency-wide measures). While the purposes for each of

FDOT's sets of measures are clear, the purpose for each of the sets of measures used by WSDOT is not distinguished. This can be a source of confusion for consumers of the performance information because they are not aware of which set of measures is most appropriate for their use.

Also, in the case studies, the number of performance measures within the sets varied based upon the intended purpose of the sets. The four states with multiple performance measures all had one set of measures for strategic planning purposes and one set of dashboard measures intended for public use. For most of the states, the number of measures included in the set intended for strategic planning purposes ranged from 20-30 measures. MDOT has a very large number of measures in its agency-wide set, with 48. MDOT's unique organizational structure may allow this -- the agency tracks a greater number of measures by delegating performance measurement responsibilities to its modal administrations. However, a reduction or synthesis of such measures seems warranted for consumption by both decision-makers and the general public. Performance dashboards typically include 15-20 measures and for states with multiple sets of measures, the number of measures in the dashboard set was less than the number of measures in the set intended for strategic planning. This is expected because the information needs of the public are not as demanding as the information needs of agency decision-makers and planners.

5.4 Calculable

For all of the five state DOTs studied, the measures identified in the performance measurement programs were nearly all calculable with current data sources. The few exceptions include transit ridership at NCDOT and greenhouse gas emissions at MDOT

and WSDOT, each of which can be calculated on numerical scales given the resources to do so. While it appears that the state DOTS had developed and identified measures to address mobility, safety, and preservation, these agencies lagged behind in developing and identifying measures relating to economic competitiveness and environmental stewardship. For example, FDOT lacked measures for its goal area of environmental stewardship and quality of life. WSDOT did not report a single measure to track its goal of economic vitality in its performance dashboard. NCDOT, MDOT, and MnDOT did not include economic competitiveness in their lists of agency goals and NCDOT did not include environment stewardship either. Therefore, no measures were identified for these goal areas in the performance measure sets used at the respective state DOTs. This suggests that state DOTs may need to invest more research into the development of measures that relate to economic competitiveness and environmental stewardship. Such reporting may need to use modeling tools or be based on indices that combine more than one simple performance measure.

For the measures that the agencies were able to calculate, the vast majority of measures were obtained in a repeated manner. Some measures that were more resource intensive to calculate were calculated on a less regular basis, such as FDOT's work program cost-benefit ratio. However, the agencies demonstrated the ability to reproduce performance measure calculations by including past performance data in bar or line graphs or by posting past performance reports on their websites. The updated calculation of measures varied within the agencies. Some were calculated on an annual basis, some on a quarterly basis, and some on an even more regular basis.

While states repeatedly calculated performance measures and had robust historic performance data, there were few instances where performance measures were actually forecasted. The only state documents found reporting forecasted performance measures came from MnDOT, and it was only able to forecast four measures: the performance measures for bridge condition, pavement condition, interregional corridors, and bus service hours. More research needs to focus on developing analysis tools to forecast future performance levels under various funding scenarios for frequently used performance measures.

5.5 Communicable

All five state DOTs that were studied use a written performance report to report detailed performance information for strategic performance measures. These performance reports typically use bar or line graphs to relay historical performance data for each of the measures or use tables to relay more complex performance information. However, WSDOT's Gray Notebook also uses pie charts and maps to convey performance measure data. The benefit to creating a performance report is the inclusion of context behind each of the performance measures, and all the states included such context. Some of the contextual information typically provided includes an explanation of the agency's efforts in attaining the performance goals, external factors that influence the performance for each of the measures, and future strategies to improve performance, among other things. The inclusion of this background information is especially important for decision-makers to understand in making important resource allocation decisions. Additionally, the performance reports are typically released on an annual basis. An exception here is

WSDOT's Gray Notebook, which is released on a quarterly basis, with different combinations of performance measures in each quarterly report.

Four of the five states, WSDOT being the exception, use an interactive performance dashboard to report strategic performance measures. These interactive dashboards typically have a home screen with links to detailed performance screens for each of the agency's goal areas. The home screens for two of the performance dashboards include graphic indicators of the agency's progress in meeting performance targets for each of the goals. FDOT's performance dashboard home screen includes graphic representations of traffic signals as indicators for each of the goal areas. Red lights refer to goal areas where the agency is not meeting its targets, the yellow lights to goal areas where the agency is nearly meeting targets, and the green lights to goal areas where the agency is meeting the targets. NCDOT's performance dashboard home screen uses dials that are representative of a car's speedometer for each of the agency's goal areas. The dials are also colored red, yellow, and green. These dials correspond to the agency's progress in meeting targets for each of the goals and use the same color representations as FDOT. The detailed performance screens in all four of the interactive dashboards reviewed include bar or line graphs that depict the trends from past performance data. The interactive nature of these performance dashboards allows users the ability to customize the amount and type of information they choose to view. This type of reporting medium is ideal for relaying performance information to the public, because it provides flexibility to users in choosing what information they access.

WSDOT calls one of its reporting documents a performance dashboard but it is not interactive like the performance dashboards of the other four case studies. In fact, it

appears to be more akin to what other agencies refer to as a scorecard, mainly because it is not interactive and is in a table form. Performance scorecards were used by three of the DOTs studied. NCDOT reports its executive performance measure in a scorecard contained in the annual report. NCDOT also reports quarterly updates of the performance scorecard as a free standing document. MnDOT uses a performance scorecard to report its strategic performance measures. MnDOT releases the updated scorecard annually. WSDOT is the third state that makes use of a performance scorecard design although they call it a performance dashboard. The performance dashboard is included in each edition of the Gray Notebook, and is therefore updated quarterly. Each of these scorecards uses similar designs to report performance information. The scorecards are set up as tables and at the very least contain columns for the current year result, the target for the current year, and a graphical indicator showing the result compared to the target for each of the measures. Both the target and result are cells filled with the quantitative numbers calculated and prescribed by the agency. The graphical indicator varies for each of the scorecards. WSDOT uses a check mark to identify performance measures where the agency met the target. MnDOT uses a red hexagon, yellow triangle, or green hexagon to show how the results compared to the target (did not meet, nearly met, and met). NCDOT shades the cells of the result with red, yellow, or green to show performance results that did not meet, nearly met, or met the targets, respectively. MnDOT also included a line graph with past performance data and additional comments for each of the measures in the scorecard. Both NCDOT and WSDOT also included graphic indicators for showing the current trends of the performance measures. WSDOT uses downward arrows, double-ended horizontal arrows, and upward arrows and NCDOT uses red,

yellow, and green circles to indicate measures that have trends that are improving, remaining steady, or worsening, respectively.

5.6 Multimodal

Three of the five state DOTs reviewed use mode-neutral measures in their performance measurement programs: FDOT, MnDOT, and WSDOT. These mode-neutral measures include total fatalities, trade import and export values, cost-benefit ratio, energy use by the transportation sector, transportation-related greenhouse gas emissions, compliance with criteria air pollutant standards, mode share, and economic indicators. However, it does not appear that these states have used these measures to make direct comparisons across modes in the past.

NCDOT however is clearly making progress towards cross-modal comparisons. The process NCDOT uses for weighing modal tradeoffs begins with grouping similar projects into prioritization buckets, mainly organized around modes. The projects are prioritized within the buckets using a scoring model that includes quantitative performance data and local input. Then the agency grades each of the prioritization buckets on a Performance LOS scale ranging from A to F. The scale rates the quality of service provided to system users for each of the buckets. The rating is based on performance data that varies for each mode. For instance, the highway mobility bucket is classified based on the percentage of miles with a volume-to-capacity ratios below .80 and the public transportation bucket is rated on the public transportation trips per year. These Performance LOS ratings are then used in a series of investment summits held by the agency where stakeholders provide input on how the agency resources should be

allocated between prioritization buckets. The result of the investment seminars is an investment strategy that is used in the programming of projects in the STIP.

Although only NCDOT is using a formalized approach to make tradeoff decisions across modes, it appears that all of the state DOTs included in the case studies are including non-highway measures to weigh the impacts of investment decisions on all transportation facilities regardless of mode. While these measures are not mode-neutral, an argument can be made that using modally inclusive performance measurement programs can be just as effective for weighing tradeoffs in cross-modal comparisons. The non-highway measures can be categorized into one of six modes/purposes: aviation, bicycle/pedestrian, cruise/ferry, intercity passenger rail, transit, and freight transportation (of any mode). Freight performance measures were the most widely included, being used by all the state DOTs. Example freight measures include the value of international imports and exports, the percentage change in Port Authority cargo movements, the average truck turn-around time at marine terminal, and the annual tonnage of shipments (port and rail). Cruise/ferry and transit performance measures were also used by four of the five DOTs reviewed. Examples of these measures are the system reliability and ridership for ferries and the number of international cruises, as well as the ridership and bus hours of service for transit. Aviation, bicycle/pedestrian, and intercity passenger rail performance measures were the least widely used of the modes, yet they still were included by three of the five state DOTs. Example measures of these three modes are percent of population with access to a paved and lighted airport, the number of bicycle and pedestrian fatalities and injuries, and on-time intercity rail performance, respectively.

5.7 Summary of Findings and Suggestions for Future Research

The **major findings** of this thesis are as follows:

- Leading state DOTs have incorporated the development of performance measures into their strategic planning processes.
- Performance measures for environmental stewardship, economic development, and quality of life considerations still lag behind measures for mobility, safety, and preservation.
- States appear to be struggling with forecasting future performance levels under various scenarios.
- Leading state DOTs have heeded the call to become more transparent-communicating performance through a number of media in order to reach multiple audiences.
- Performance measures for non-highway modes are still not as fully developed or researched as measures for highways.
- Since ISTEA, there has been a shift to a more multimodal approach to transportation planning and the new requirements in MAP-21 have increased the emphasis on performance measurement. At the confluence of these two fields is an opportunity to undertake a scientifically supported trade-offs of multimodal alternatives.
- There is no single, well-established procedure or technique for multimodal tradeoff analysis that has emerged that state DOTs have shown interest in adopting.

- As far as multimodal tradeoff analysis is concerned, there is a reasonable discussion about the need for mode-neutrality. However, developing mode-neutral performance measures is difficult, and, more importantly, may not be the answer that planning agencies are looking for. Alternatively, an emerging trend in state DOTs is the idea of modal inclusivity. This is the practice of measuring the performance within modes, but considering the performance of all the modes in an agency's resource allocation decisions. This approach has the benefit of providing decision-makers with insight into performance of the entire transportation system as well as insight into deficiencies in particular modes of the transportation network.
- There have been a number of efforts to create performance measurement systems that are analogous across all modes of transportation, most notably the use of Level of Service (LOS) measures. While these measurement systems are computed in different ways for different modes, the results are presented in comparable rating systems (e.g. an 'A' through 'F' traffic congestion rating system). This is a promising technique that could be used for future evaluations of tradeoffs involved in choosing between modes.

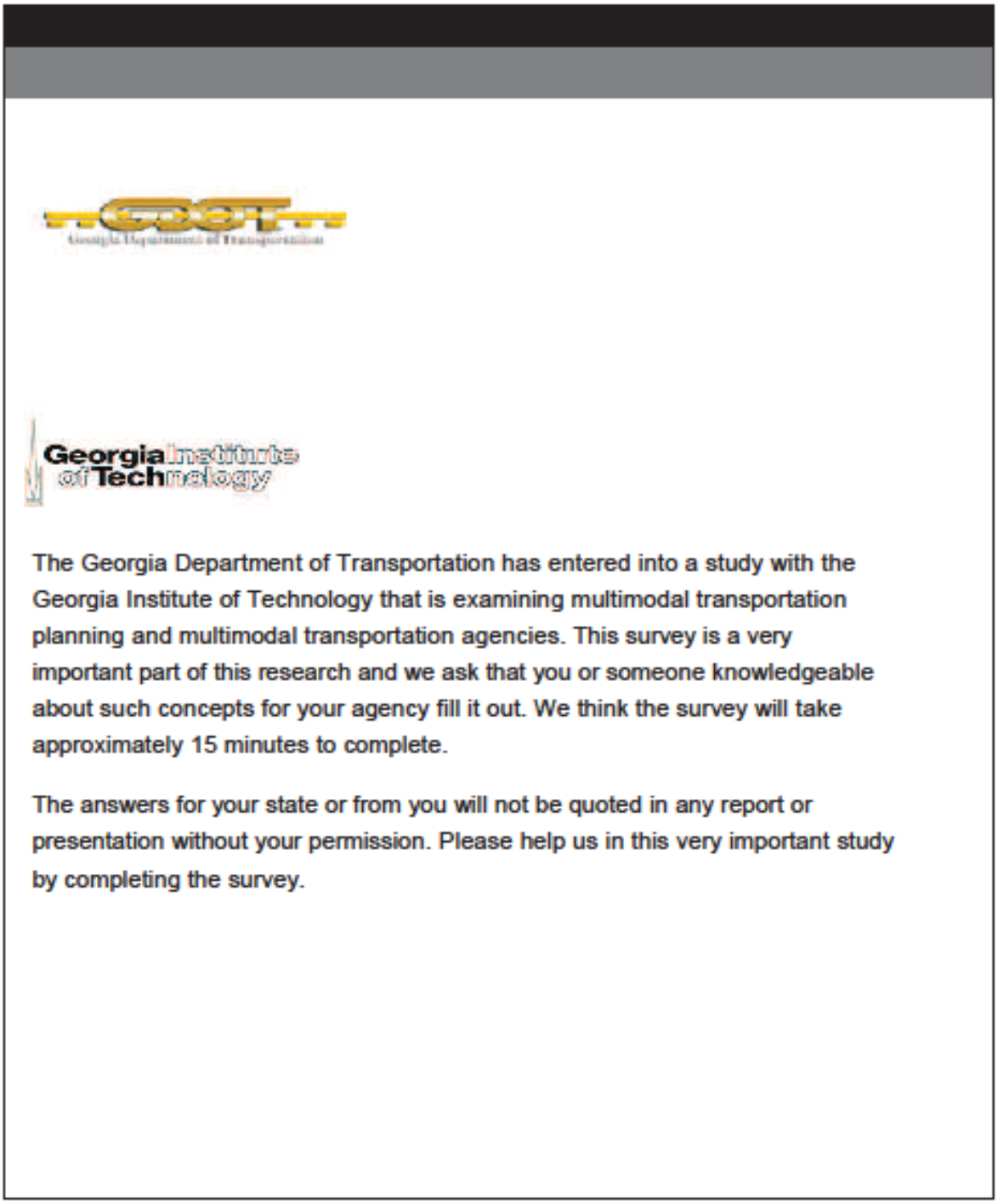
Given the findings in this research, **future research** should focus on a few key areas:

- Developing performance measures that consider environmental stewardship, economic development, and quality of life.

- Creating methodologies and analysis tools to project future performance levels under a wide range of funding scenarios.
- Developing performance measures and improving data collection for non-highway modes.
- Continuing the development of a methodology to compare performance across modes.
- Refining or developing LOS, and other related ratings systems, for all modes of transportation.
- Further integrating performance measures into the long range/strategic planning process in ways that improve the quantitative assessment of future transportation system improvement proposals.
- Continuing to develop and experiment with new ways and new forms of media to help both decision-makers and the general public to visualize the proposed performance enhancements associated with specific elements of a state's transportation plans.

APPENDIX A.

NATIONWIDE SURVEY OF MULTIMODAL PRACTICES



The Georgia Department of Transportation has entered into a study with the Georgia Institute of Technology that is examining multimodal transportation planning and multimodal transportation agencies. This survey is a very important part of this research and we ask that you or someone knowledgeable about such concepts for your agency fill it out. We think the survey will take approximately 15 minutes to complete.

The answers for your state or from you will not be quoted in any report or presentation without your permission. Please help us in this very important study by completing the survey.

State Multimodal Survey

1. In what state are you located?

2. Do you work for the state DOT?

yes

no

3. If not, what agency do you work for?

State Multimodal Survey

4. If you work in a state DOT, which of the following modes of transportation does your state DOT have some responsibility for? Please indicate who is responsible for each mode so indicated. (Note all that apply)

	Planning	Intermodal Bureau or Division	Mode-Specific Bureau or Division	Special Unit within Secretary's/Director's office	Other
Transit (Operator of some transit services)	○	○	○	○	○
Transit (Funder or provides subsidies)	○	○	○	○	○
Port (Operator)	○	○	○	○	○
Port (Dredging)	○	○	○	○	○
Ferry (Operator of some ferry services)	○	○	○	○	
Ferry (Funder or provides subsidies)		○ ○	○	○	○
Inland water/river (Funder or provides subsidies)		○ ○	○	○	○
Shortline Rail (Operator of some shortline services)		○			
	○	○	○	○	○
Shortline Rail (Funder)	○	○	○	○	○
Airports (Operator of some state airports)	○	○	○	○	
Airports (Funder or provides subsidies)		○ ○	○	○	○
Aviation Services (Funder or provides subsidies)		○ ○	○	○	○
Ridesharing Services (Operator)		○ ○	○	○	○
Ridesharing Services (Funder or provides subsidies)		○ ○ ○	○	○	○
Intercity Bus Services (Funder or provides subsidies)	○	○	○	○	○
Pedestrian/Bicycle (Operator of some ped/bike facilities)	○	○	○	○	○
Pedestrian/Bicycle (Funder or provides subsidies)	○	○	○	○	○

If other is selected for a mode, please identify who is responsible for the mode. Also, if there is a mode your DOT is responsible for that is not listed above, please identify the mode as well as who is responsible for it.

5

6

State Multimodal Survey

5. Does your agency develop mode-specific plans and/or a multimodal plan?

Mode specific plans

Multimodal Plans

Both

What efforts exist to integrate the various plans?

6. In your opinion, to what extent does your agency conduct multimodal transportation planning that examines different modal strategies among the state-responsible modes indicated in #4 above?

1 (very little)

2

3 (moderate amount)

4

5 (to a great extent)

not applicable

7. To what extent are different modal options compared to one another in the planning/programming process to determine the most cost effective investment for the state?

1 (very little)

2

3 (moderate amount)

4

5 (to a great extent)

not applicable

8. If different modal options are compared to one another, are there specific evaluation criteria that are used to conduct such a comparison?

yes

no

don't know

not applicable

State Multimodal Survey

9. In your opinion, over the past 10 years, to what extent has your agency been incorporating a more multimodal approach into transportation planning and programming?

- 1 (very little)
- 2
- 3 (moderate amount)
- 4
- 5 (to a great extent)
- not applicable

10. Does your state have a transportation trust fund whose funds can be used for any mode of transportation?

- yes
- no
- don't know

11. Does your state have separate funding programs for non-highway modes, such as a freight rail investment program, ports program, airport improvements, etc? (Note: this includes funding programs outside of your agency, but still using state funds, such as a freight facility investment program)

- yes
- no
- don't know

Please identify such programs.

State Multimodal Survey

12. If your answer to #11 is yes, which of the following modes are funded with state funds? Indicate which types of funding can be used for each mode that is funded.

	Dedicated transportation funds to this mode	General state funds	Bond funding	Motor fuel taxes	Other motor vehicle taxes	Other
Transit						
Port						
Ferry						
Inland water/river						
Shortline rail						
Airports						
Aviation services						
Ridesharing services						
Intercity bus services						
Pedestrian/bicycle						

If the type of funding for a mode is "Other", please identify the type of funding. Also, if your state funds other modes not listed above, please identify the modes and the type of funding they receive.

13. Given your experience with multimodal transportation planning, identify three of the most important reasons that can explain why such planning has not been undertaken more fully in your agency.

- Modal funding categories focus our attention on mode-specific plans/programs
- State government and agency leadership is not emphasizing multimodal plans
- We are not organized to conduct multimodal planning
- Agency history and culture are not conducive to multimodal planning
- Agency standard operating procedures and processes are mode-specific
- Very few analysis tools/models exist to conduct multimodal planning
- Staff capabilities and background are not conducive to multimodal planning
- Agency constituency groups and lobbyists do not support multimodal planning
- Other agencies (e.g., MPOs, transit, ports) already do multimodal planning

Other (please specify)

State Multimodal Survey

14. If you are an employee of a state DOT, please indicate the number of full time employees in the state DOT.

15. If you are an employee of a state DOT, estimate the number of employees in the state DOT that deal primarily with the planning for the following modes. (Note: Do not double count. If one employee is equally responsible for port and inland water, count each as 0.5 employees). Round your final number to the nearest whole number

Transit	
Port	
Ferry	
Inland water/river	
Shortline rail	
Airports	
Aviation services	
Ridesharing services	
Intercity bus services	
Pedestrian/bicycle	
Other	

16. What do you think are the most critical issues relating to statewide multimodal transportation planning in your state?

17. What are the characteristics that are necessary in a state DOT to be considered a multimodal agency?

18. In your opinion, are there examples of multimodal planning in your state that could be pointed to as good examples of such planning? If so, please describe below.

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