# Best Practices for Performance Measurement in Transportation Operations and Maintenacne

Report Number: KTC-21-24/SPR20-591-1F

DOI: https://doi.org/10.13023/ktc.rr.2021.24

Kentucky Transportation Center
College of Engineering, University of Kentucky, Lexington, Kentucky

in cooperation with
Kentucky Transportation Cabinet
Commonwealth of Kentucky

The Kentucky Transportation Center is committed to a policy of providing equal opportunities for al persons in recruitment, appointment, promotion, payment, training, and other employment and education practices without regard for economic, or social status and will not discriminate on the basis of race, color, ethnic origin, national origin, creed, religion, political belief, sex, sexual orientation, marital status or age.

Kentucky Transportation Center
College of Engineering, University of Kentucky, Lexington, Kentucky

in cooperation with
Kentucky Transportation Cabinet
Commonwealth of Kentucky



KENTUCKY Transporation Center

Kentucky Transportation Center • University of Kentucky
176 Raymond Building • Lexington, KY 40506 • 859.257.6898 • www.ktc.uky.edu

University of Kentucky

**Research Report**
KTC-21-24/SPR20-591-1F

# Best Practices for Performance Measurement in Transportation Operations and Maintenance

Bryan Gibson, Ph.D.
Program Manager

Rachel Catchings, MSCE, P.E.
Program Manager

Chris Van Dyke, Ph.D.
Research Scientist

Steve Waddle, MSCE, P.E.
Research Engineer

and

Doug Kreis, Ph.D., P.E.
Director

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

In Cooperation With
Kentucky Transportation Cabinet
Commonwealth of Kentucky



December 2021

| | | |
|---|---|---|
| **1. Report No.**<br>KTC-21-24/SPR20-591-1F | **2. Government Accession No.** | **3. Recipient's Catalog No** |
| **4. Title and Subtitle**<br>Best Practices for Performance Measurement in Transportation Operations and Maintenance | | **5. Report Date**<br>December 2021<br>**6. Performing Organization Code** |
| **7. Author(s):**<br>Bryan Gibson, Rachel Catchings, Chris Van Dyke, Steve Waddle, Doug Kreis | | **8. Performing Organization Report No.**<br>KTC-21-24/SPR20-591-1F |
| **9. Performing Organization Name and Address**<br>Kentucky Transportation Center<br>College of Engineering<br>University of Kentucky<br>Lexington, KY 40506-0281 | | **10. Work Unit No. (TRAIS)**<br>**11. Contract or Grant No.**<br>SPR 20-591 |
| **12. Sponsoring Agency Name and Address**<br>Kentucky Transportation Cabinet<br>State Office Building<br>Frankfort, KY 40622 | | **13. Type of Report and Period Covered**<br>**14. Sponsoring Agency Code** |
| **15. Supplementary Notes**<br>Prepared in cooperation with the Kentucky Transportation Cabinet | | |


**16. Abstract**

Public agencies benefit from measuring their performance as it helps to focus employee and organizational activities. State departments of transportation have become more performance-oriented over the past two decades and routinely collect data on highway safety, infrastructure condition, system operations, project delivery, winter maintenance, transit, bicycle and pedestrian facilities, and customer service. While the Kentucky Transportation Cabinet (KYTC) use performance measures in a variety of areas, the agency wants to adopt new metrics related to mobility and the responsiveness of maintenance operations. This report documents performance measurement strategies used at state transportation agencies throughout the country and proposes new performance measures in these areas for KYTC. Among the performance measures put forward to the Cabinet, the following ones ranked most highly: (1) response times for complaints and potholes, (2) contract response time, (3) percentage of time and money spent on routine and emergency maintenance of drainage, guardrail, and cable median barriers, (4) response time to repair guardrail and cable median barriers, and (5) winter maintenance operations. As KYTC further integrates performance measures into its operations, it is critical to clearly communicate performance information to the public using tools such as online dashboards and reports.


| | | | |
|---|---|---|---|
| **17. Key Words**<br>performance measurement, performance management, maintenance, mobility, reliability | | **18. Distribution Statement**<br>Unlimited with approval of the Kentucky Transportation Cabinet | |
| **19. Security Classification (report)**<br>Unclassified | **20. Security Classification (this page)**<br>Unclassified | **21. No. of Pages**<br>97 | **19. Security Classification (report)** |

## Table of Contents

## List of Figures



## List of Tables

## Executive Summary

Many public agencies rely on performance measurements to keep employees focused on fulfilling organizational missions and ensure division-level performance targets are met. The Kentucky Transportation Cabinet (KYTC) uses performance measures to monitor operations and maintenance activities, which focus on responding to customer needs, keeping travelers safe, sustaining mobility, and preserving assets in a state of good repair. The transparent application of performance measures helps ensure maintenance work and associated functions remain at a high level. Wanting to deepen its commitment to performance measurement and transparency KYTC commissioned Kentucky Transportation Center (KTC) researchers to review literature on performance measurements and metrics used at other state departments of transportation (DOTs) and — based on this information — propose performance measures which the Cabinet will benefit from implementing.

Ample research has demonstrated that at performance measure are valuable for determining funding allocations, assisting with statewide planning, keeping an organization responsive to its stakeholders, quantifying the benefits of programs (e.g., maintenance, pavement preservation), and meeting federal and state legislative requirements. Publishing intuitive, easy-to-interpret performance measures benefits all stakeholders, increases organizational accountability, and facilitates continuous improvement in operations. Actionable information that is generated by performance measures also strengthens the decision making of agency leadership. Whether performance measures succeed is contingent on the level or staff engagement and the presentation of data. A useful approach is to develop consistent, unified performance measures that can be easily updated and which provide insights from system (i.e., roads, bridges, and even multimodal approach) and budgetary perspectives. Ideally, any performance measure should adhere to SMART (specific, measurable, attainable, relevant, and time bound) criteria.

State DOTs vary in their data collection practices and how routinely they publish performance measure—related information on internal- and public-facing platforms. MAP-21 mandates that agencies gather data on highway safety, infrastructure condition, and system performance. In addition to complying with federal regulations, most DOTs have adopted other performance measures to understand their strengths and weaknesses in areas such as mobility (e.g., travel time reliability, delays), project delivery, winter maintenance operations, transit service, bicycle and pedestrian facilities, environmental stewardship, customer service, and accountability. The most common methods used by DOTs to communicate and display performance measurement data include (1) online dashboards with intuitive graphs and symbology and (2) reports/scorecards that are issued at intervals ranging from every quarter to once per year.

Before the research team identified new performance measures that can be introduced at KYTC, it inventoried performance measures currently used at the agency. The Cabinet collects significant quantities of data as part of its Maintenance Rating Program (MRP). Each year, the MRP samples 300-400 road segments throughout the state to document whether maintenance and upkeep are sufficient. DataMart is an interactive, centralized online data repository created in response to MAP-21 requirements. It stores data related to Cabinet assets, safety, traffic, financial information, and other elements. DataMart helps keep KYTC accountable to the public and shines a light on the agency's stewardship of public funds. Motorists can access real-time traffic and road condition data via GOKy's interactive web map, while the Snow and Ice Decision Support Dashboards handle millions of records per day during winter maintenance operations. KYTC's Division of Planning collects data on mobility and reliability, including volume-to-capacity ratio, level of service, travel time index, buffer index, and the planning time index.

Following the review of KYTC's data collection procedures and performance measures, researchers — with input from Cabinet staff — developed a framework to identify new metrics focused on responsiveness and mobility. The focus on these areas emerged because Cabinet staff feel confident that performance measures used to evaluate asset conditions produce sound results. Table E1 lists proposed performance measure for both areas. Most metrics would be calculated on an annual basis, but given the agency's recent strides in big data, more frequent updates are possible. intensive dashboards to disseminate information on performance measures. Regardless of the mode of presentation ultimately chosen, it is critical to present data as clearly as possible so it can be understood by a wide audience.

**Table E1** Potential Responsiveness and Mobility Performance Measures

| **Responsiveness Performance Measures** |
|---|
| Average response time for complaints (by type) |
| Pothole repair responsiveness |
| Drainage pipes and ditches — Percentage of time and money spent on routine maintenance |
| Drainage pipes and ditches — Percentage of time and money spent on emergency maintenance |
| Contract response time |
| Crew — number of safety incidents |
| Guardrail and cable median barrier — Response time to repair damaged sections |
| Guardrail and cable median barrier — Cost and time to repair |
| Percentage of time and money spent on routine maintenance |
| Percentage of time and money spent on emergency maintenance |
| Snow and ice events — Time to clear based on severity |
| Snow and ice events — Cost per year/event (based on precipitation, number of events) |
| **Mobility Performance Measures** |
| Vehicle miles travelled |
| Average incident clearance times |
| Reliability (e.g., travel times) |
| Congestion |
| Delays |
| Customer Service and Satisfaction |
| Work Zone Delays / Impacts |
| Average travel speeds |
| Average delay per person |
| Snow and ice clearance |
| Snow and ice mobility |
| Level of service targets |

* Tables 4.3 and 4.4 in the main document provide additional details on each measure

Several proposed measures were rated highly by Cabinet personnel, including:

- Response time for complaints and potholes
- Contract response time
- Percentage of time and money spent on routine and emergency maintenance of drainage, guardrail, and cable median barriers
- Response time to repair damaged guardrail and cable median barriers
- Snow and ice expenses and clearance times based on severity

Before new performance measures are introduced, KYTC should develop a communications plan that specifies how information will be made available to Cabinet staff and the public.

# Chapter 1 Introduction and Background

From an organizational perspective, what gets measured gets managed and what gets measured gets done. Routine performance measurement and reporting focuses an organization and its staff, improving work results. The Kentucky Transportation Cabinet (KYTC) wants to implement new performance measures in transportation operations and maintenance. The agency's maintenance activities and operations are directed by several core functions, including responding to customer needs, ensuring the travelling public's safety, sustaining mobility, and maintaining assets.

The transparent application of performance measures can help to keep maintenance activities at the highest level possible. These metrics can be used to assess how a system is functioning and evaluate whether they are meeting customer needs and expectations (National Research Council 1996). Performance measures can also help determine resource allocation and track overall progress toward a set of goals and/or objectives (Neumann and Pickrell 2001). AASHTO (2007a) notes that performance measures can be used by states to help:

- Determine funding allocations
- Assist with statewide planning
- Ensure that the organization is responsive to its stakeholders
- Quantify the benefits of programs such as pavement preservation
- Meet federal and state legislative requirements

Deploying intuitive and easy-to-interpret performance measurement benefits stakeholders, increases organizational accountability for its activities, and helps organizations continuously improve their operations. Usable performance measures that generate actionable data can help inform management decisions and focus employees (Tsang et al. 1999). Employee engagement and the presentation of results are critical if performance measurement programs are to succeed (Yurek et al. 2012). Data are collected on many facets of transportation maintenance and operations, however, identifying best practices to create meaningful performance measures is challenging. Gibson et al. (2015) recommended developing consistent, unified performance measures that are easy to update and informative for policymakers from a system (roads, bridges, and even multimodal approach) and budgetary perspective. External factors can impact performance measures and may be worth including to illustrate certain outcomes (Dadashova et al. 2018). While there may be multiple facets of operations and maintenance that can be measured, it is important to identify a few goals that integrate division-level inputs and help measure what impacts project delivery and preservation. Such performance measures help build public confidence in agency responsiveness to complaints, maintaining mobility, snow and ice, and emergency events. The end goal of developing performance measures is to be accountable internally as well as to the travelling public. This fosters a culture of accountability and delivery. Incorporating consistent performance measures into project delivery and preservation improves the public and legislators' perceptions of an agency's ability to deliver promised projects and lets both stakeholder groups review project progress.

This report examines best practices for performance measurement used at different state transportation agencies with the goal of identifying performance measures appropriate for implementation in Kentucky. Any performance measure adopted should adhere to the SMART (specific, measurable, achievable, relevant, and time-bound) criteria. The report also discusses the use of performance measures to prioritize activities in maintenance and operations.

### 1.1 Study Objectives

- Document what data are available to facilitate performance measurement.
- Develop performance measures for maintenance and operations.

### 1.2 Report Structure

Table 1.1 summarizes the report structure and contents.

**Table 1.1** Report Structure

| Chapter | Material |
|---|---|
| 2 | • Literature review on performance measures, including the structure of performance measures and elements of good performance measures |
| 3 | • Provides background on performance measures from the perspectives of the federal government and state transportation agencies<br>• Performance measures that consider asset condition, responsiveness, and mobility are highlighted |
| 4 | • Reviews KYTC's current data collect efforts related to performance and recommends prospective performance measures for mobility and responsiveness |
| 5 | • Concluding thoughts and highly rated performance measures |

## Chapter 2 Literature Review

In an era of increased customer expectations, greater demands for accountability, and limited budgets, public agencies benefit from developing a clear set of realistic performance measures. Performance measurement is now becoming institutionalized at many transportation agencies (Margiotta 2007, p. 6). In 2003, Shaw found that the average age of transportation agency performance measurement programs was 14 years old, with organizations adopting a wide range of measures and techniques for reporting and data collection. Developing performance measures can benefit policymakers by providing them with data to improve operations (Poister 1982). Monitoring the current status the status of performance measure implementation fosters organizational responsibility both internally and externally.

Discussion of performance measures often invoke *performance management*. There are subtle differences between these concepts. The Urban Institute defines performance measurement as "a tool to help government agencies and nonprofits know whether their programs and services are leading to desired results."[1] Performance management utilizes performance measures as part of a more comprehensive approach to identifying the audience, what to measure, required data sources, and analyzing and reporting results. In some sense, performance management is the continual refinement and utilization of performance measures to meet organizational objectives and/or goals. Hendren et al. (2005, p. 129-130) write that, "Performance-based management is grounded in three components: program development, project delivery, and system monitoring and reporting." In the context of this project, both approaches have merit and are reviewed.

Motivations behind transportation performance measures can be legislative, agency-driven, or a more formal planning approach (Margiotta 2007). Reviews of state activities have reinforced these findings, including governors and transportation commissions along with legislators, as well as funding for accountability (Larson 2005). Other factors driving the use of performance measures are increased demands for accountability and public sector improvements, leadership and a desire for organizational excellence, and environmental changes requiring new approaches to transportation and thus the need to measure for success or failure (Poister 2005). Shaw's (2003) survey of state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) identified several reasons for using performance measures: legislative mandates, planning processes, quality initiatives, congestion management systems and evaluation, ITS operations and evaluations, safety management systems, and permit processes. When identifying performance measures, agencies must fully comprehend their mission and consider how the results may be interpreted to support continuous improvement (Kassoff 2001). There are guidelines for determining what performance measures to implement (National Research Council 1996, p. 66-67), including:

- Each performance measure should be appropriate and provide useful information for decision makers and stakeholders by reflecting specific goals
- Selected performance measures should function as a group to help provide a complete performance assessment, ensuring both qualitative and quantitative measures, identifying future performance and needs, and facilitating comparisons as needed
- Costs of the performance measures must be reasonable compared to potential consequences and magnitude of the decisions being made as a result of the measures.

Early literature on state DOT performance measures found that interest in performance measures emerged in response to factors such as needing information to support planning efforts, public and legislative demands for increased accountability, legislative mandates, increasing threats of privatization, and recognizing the need to focus on delivering for customers (Poister 1997). Pickrell and Neumann (2000) identify accountability, efficiency, effectiveness, communications, clarity, and improvements as motivations behind the adoption of performance measures. Margiotta (2007) pointed to the increasing emphasis on measuring reliability and the ability of

[1] https://www.urban.org/research/data-methods/data-analysis/quantitative-data-analysis/performance-measurement-and-management

performance measures to assist in identifying deficiencies, improving public relations, and generating data on outcomes that can be used to inform decision making. When performance measures are used as part of an effort to manage programs more efficiently — rather than simply complying with a reporting requirement — they are more likely to generate accurate data (Positer 1997). Successful performance measurement programs have robust data collection methods, clearly tie outcomes and outputs to agency mission, and produce tailored communications that summarize important findings. Neely et al. (1997, Table IX, p. 1151) recommend a performance measures record sheet to assist in the design of performance measures. The sheet includes information such as the title of the measure, its purpose, target, formula, frequency of measurement and review, who is conducting the measurement and making decisions based on the information, and data sources, among others.

Neely et al. (1997, Table I, p. 1137) also compiled a list of recommendations for developing performance measures. The most salient recommendations are reviewed briefly here. Performance measures should be easy to understand, be a visually impactful, and focus on improvement (Lea and Parker 1989) while providing valid feedback and relating to specific goals (Globerson 1985). Performance measures have generally been viewed as a way to quantify how effective an action is in practice and the strategic context. While there are various ways to classify performance measures, their effectiveness is likely tied to resource allocation, structure, and rewards (Neely et al. 1995). Lacking performance measures, particularly well-defined measures, to evaluate the organization and individual employee performance limits management's ability to plan (Globerson 1985). From that set of recommendations Neely et al. (1997) use that information to develop a framework for performance measurement focusing on 10 different elements listed below.

1. Clear title
2. Purpose of the performance measure
3. Relationship to business goals or objectives
4. Target or level of service desired
5. Formula for calculating measure
6. Frequency of measuring and recording
7. Who is responsible for measuring
8. Data sources
9. Who is responsible for making decisions based on the performance measure
10. What the decision makers choose to do as a result of the performance measure

Implementing performance measures provides several tangible benefits, such as improving accountability, improving communication to the public, increased organizational efficiency and effectiveness when focusing on and achieving objectives, and a process for ongoing improvement by integrating feedback into decision making (Cambridge Systematics et al. 2006). Atkinson et al. (1997) recognize three roles for performance measures: coordination, monitoring, and diagnosis. Performance measures can help support policy and investment decision making and gauge the effect of decisions (Grant et al. 2013). From a maintenance perspective, using performance measures can help prioritize limited resources in the most effective manner possible (Yurek et al. 2012). This approach to using performance-based budgeting can assist policymakers in directing funding towards identified areas of poor performance. Performance measures can also be evaluated and improved over time. Shaw (2003, Table 18, p. 47) identifies basic criteria by which to evaluate performance measures: clarity and simplicity, descriptive and predictive ability, analytical capability, accuracy and precision, and flexibility.[2] General observations on design of performance measures follow (Tsang et al. 1999, p. 696):

- Measures are organization-specific; they are linked to the organization's strategy
- Multiple measures — internal and external, financial and non-financial measures, performance drivers, and outcome measures — should be used to achieve balance in perspective and communicate causal relationships for achieving business success.
- Measures should be user-friendly — simple, easy to use, available promptly.

[2] For a list of the highest scoring measures see pp. 47-49.

- Measures at different levels of the hierarchy are aligned and they are integrated across an organization's functions.
- Involve employees in formulating strategies and identifying the related performance measures.
- The organization's infrastructure encourages desired behavior and supports operation of the measurement system.
- Effectiveness of the system and its contribution to overall organizational performance are reviewed periodically to allow changes and improvements to be made.

Dalton et al. (2001, p. 75-76) also cite the following as functions of performance measures:

- Address the concerns of three groups affected by the agency's vision and goals: customers, stakeholders, and employees. The interests of these three groups must be balanced in the measures selected. Management must avoid narrowly concentrating on measures of concern to only one group.
- Have relatively few measures so that attention is focused rather than scattered. Performance measures are often likened to the gauges of a dashboard. Several gauges are essential, but a vehicle with too many gauges is distracting to drive.
- Have a clear and definable relationship to the agency's goals. The best measures provide a direct link from business unit performance plans to the agency's vision. Measures that are indirectly related to the agency's vision and goals are less effective tools in managing the agency and improving performance.
- Obtain buy-in from customers, stakeholders, and employees. If these groups do not consider the measures appropriate, it will be impossible to use the results of the analysis process to report performance and negotiate the changes needed to improve it.
- Change slowly as the goals of the agency change in response to changes in the concerns of individual groups and as process improvements enhance performance in particular areas. In other words, once established, performance measures should be in place long enough to provide consistent guidance in terms of improvements and monitoring to determine whether the objectives are being met.
- Facilitate improvement. If performance measures are not clearly for the purpose of improving the products and services of an agency, they will be seen as mere report cards and games will be played simply to get a good grade.

Identifying performance measures for asset management consists of focusing on potential measures that are responsive to policy objectives, having a strategic perspective of overall performance and cost, an understanding of the tradeoffs and options available, the presence of good data and information, and the ability to link the measures to a feedback loop (Cambridge Systematics et al. 2006). Guidance for performance measures detailed in the report are broken into identification, integration, and establishment of targets (Figure 2.1).

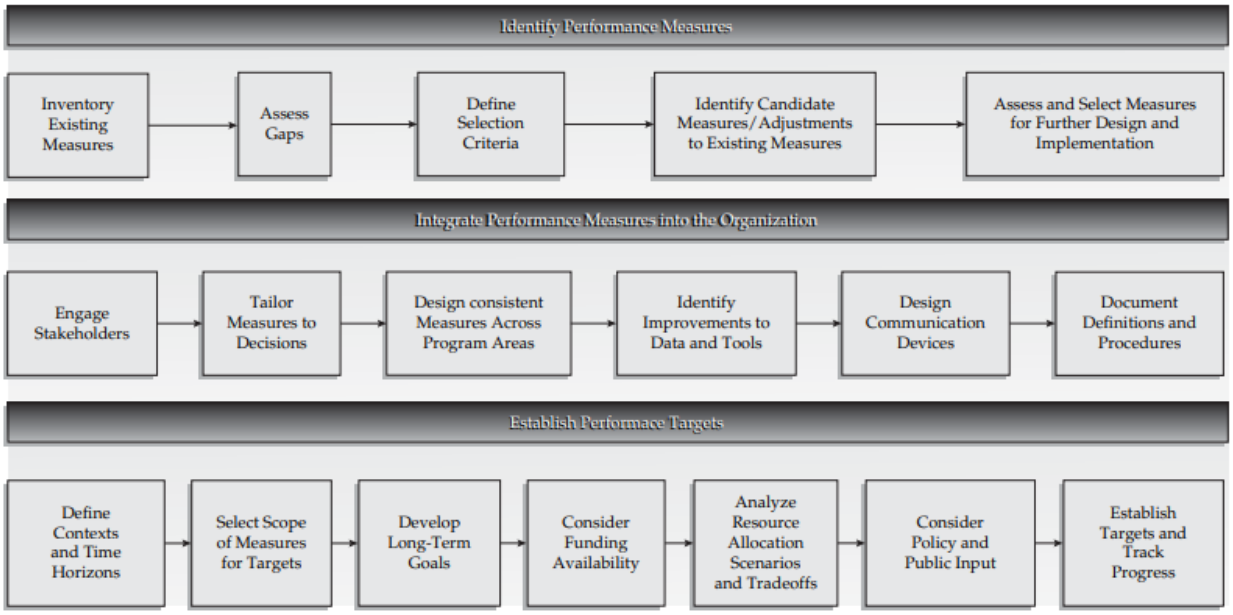



**Figure 2.1** Performance Measure Guidance

Spy Pond Partners et al. (2019, Figure 2-3, p. 11) developed an example logic map (Figure 2.2) that can be used to develop performance measures. The map includes inputs, activities, and measures divided into outputs and outcomes. As part of the development process, factors outside the process that may impact performance should also be noted and understood, if possible.

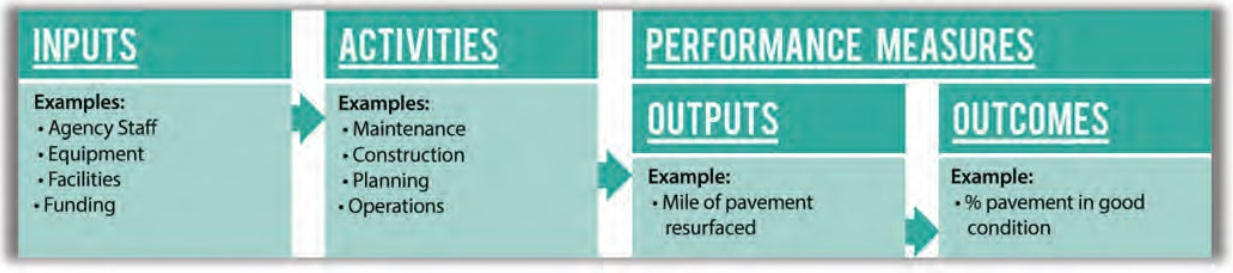



**Figure 2.2** Logic Map for Developing Performance Measures

Dalton et al. (2001) list a four stages of performance measurement with feedback loops at each stage. The four stages are identifying specific goals, developing measures that correspond to the goals, collecting data, and then analyzing and reporting results. ICF et al. (2019, p.89, p. 127, p. 133, p. 140) list four steps to define performance measures, two implementation steps, two steps for using performance measure information, and two steps for reinforcing a performance-based approach. Although these are within the context of snow and ice response performance measures, the approach can be used in other areas of maintenance or operations.

1. Review the organization's mission and goals
2. Refine its operational objectives, which help identify goals the organization is trying to achieve
3. Identify performance measures, including potential limitations and data requirements
4. Develop analytical approaches to consider targets, external factors, comparison points, etc.
5. Inventory current practices and identify gaps
6. Identify data sources and data needs
7. Set targets and establish the baseline
8. Report performance
9. Integrate the performance measure process into decision making

10. Evaluate and improve

Early performance measures at the state level focused on traditional areas such as safety, maintenance, and construction (Poister 1997). Similar themes persist in later research, with agencies reporting measures for asset management in categories such as asset preservation, mobility, operations and maintenance, and safety. When targets are set funding levels, goals, public input, existing conditions and trends, industry conversations, and tradeoff analyses among factors are considered (Cambridge Systematics et al. 2006).[3] Other categories noted were environmental impacts, economic development, social impacts, security, and delivery. Trends in performance measurement in the early 2000s emphasized strategic measures, outcomes, and customer-centered measures; an increased use of performance measures while focusing on the most important strategic objectives; and increased reporting through methods such as report cards (Poister 2005). Nationally, performance measures have often centered on safety, infrastructure condition, freight mobility, mobility, environment, and livability (Yurek et al. 2012, p. ES-1). Measuring throughout the process of improving assets or delivering a service can expedite the process of identifying problems and addressing them. In some sense, performance measurement can add a continuous feedback loop for the organization (Cambridge Systematics 2000) or help identify gaps in performance and additional measures that may be needed (Spy Pond Partners et al. 2019). Organizations can have internal and external measures with either a long- or shorter-term focus. From a planning perspective, performance measures can be broadly categorized into "accessibility, mobility, economic development, quality of life, environmental and resource conservation, safety, operational efficiency, and system condition and performance" (Cambridge Systematics 2000, p. 15).

Data collection and data quality remain key underpinnings of any performance measurement system. Cambridge Systematics (2013) examine planning performance measurement, specifically the importance of reliability and using performance measures to help allocate funding. Having institutional and stakeholder buy-in are important components of an performance-based process, while travel time reliability and mobility cross functional areas. Certainly, reliability as a relatively generic descriptor can be translated into planning performance measurement as well as operations and maintenance. Performance measures have also been used to assess the performance of local public agency (LPA) projects (McCarthy et al. 2013). Surveying state DOTs and LPAs revealed several insights into how these projects unfold and — if they are measured — what those measures are. Those that utilized performance measures were focused on accountability in project delivery through time to delivery and remaining within budget. Determining the allocation of federal funding in some cases depended on delivery and budget factors as well as past performance history. Other measures are requirements for reporting, the use of a project manager, checklists, consistent quality assurance processes, and monthly or quarterly meetings among others.

Performance-based management of maintenance and operations is another approach that has become more widely used in state DOTs (Markow 2012). As part of NCHRP Synthesis 426, Markow (2012) surveyed state DOTs on performance-based maintenance and operations management and found that 75% of respondents reported programs either in use or under development.[4] Variations among active programs consisted of the assets measured or addressed, the types of measures, and the use of information gleaned from measures (e.g., informing or examining historical trends). Commonalities across survey respondents were noted as there was general uniformity in measurement across states with exceptions made for factors such as weather, differing traffic levels, and influences on the level-of-service targets, including anticipated budgets and agency goals. Underlying data used are often in-person inspections done to support the programs and feedback solicited from the travelling public. Communication was viewed as an important aspect of performance-based programs and is facilitated by methods such as dashboards and report cards.

A method of measurement specific to maintenance is maintenance quality assurance (MQA), which "is a process that uses quantitative or qualitative indicators to assess the performance of maintenance programs (Smith and

[3] Cambridge Systematics et al. (2006) Appendix A pp. A-1- A-14 contains a list of performance measures while Appendix B pp. B-1- B-5 lists several state DOT performance targets.

[4] See Markow (2012) Appendix A on pp. 61-71 for survey questions, Appendix B on p. 72 for a list of respondents, and Appendix D on pp. 78-87 for responses.

Adams 2005, p. 2). MQA is another way of tackling maintenance levels of service and addressing functional performance in terms of meeting basic objectives such as safety and mobility (Dye et al. 2010). Performance measures are necessary for an effective MQA program (Hyman 2004). Factors which motivate the establishment of MQA programs include the need to improve accountability and management of the maintenance program as well as legislative requirements (Smith and Adams 2005). MQA programs aim to identify weaknesses in maintenance approaches and materials (Stivers et al. 1999), and data generated from MQA programs can help in other areas of decision making (Smith and Adams 2005). Smith and Adams (2005) explore traffic management through an MQA lens, identifying maintenance features such as signs, guardrail, striping, lighting, and signals among others. They note their characteristics, a standard of care, and relevant performance measures such as percent of damaged guardrail, number of signs deficient or missing, worn or missing striping, number of deficient lights, and number of signals with outages or improper operation/damage.

MQA programs can benefit agencies seeking to meet level of service targets focusing on uniformity across the system (Stivers et al. 1999). Identifying a desired level of service and targeting funding levels to meet that, along with prioritizing activities when funding is not sufficient to meet all identified needs, are objectives to consider when evaluating maintenance operations and potential changes. Striving for uniformity across the maintenance enterprise and identifying competencies needed to handle certain tasks are worthwhile exercises as well. A prototype MQA program is one that has organizational commitment and awareness, training offerings for employees, empowerment of employees, periodic assessments, tracking progress toward quality goals, and maintaining open lines of communication. Stivers et al. (1999) are more focused on the quality of management and its impact on the outcomes seen in maintenance activities. MQA programs are useful when assessing maintenance needs and are most effective when an organization is committed to using data to improve decision making (Yurek et al. 2012). Underlying MQA data are also often rolled up to yield a single score representative of the agency's overall maintenance efforts. Recommendations for enabling performance-based, MQA, or similar programs for maintenance activities include measuring and using approaches that align with higher level goals, reporting results and progress toward targets, seeking ways to improve data and new technology, training employees, sharing experiences with other states, and promoting the use of performance measure-based programs through marketing, documentation of programs, and identification of best practices (Yurek et al. 2012). Markow (2012, p. 1) writes that, "Performance-based management is a more current usage that incorporates the elements and procedures recommended by MQA, but strengthens and re-emphasizes some aspects originally proposed in MWQ and stresses additional capabilities and perspectives as well." MQA programs have some elements of performance measurement and the concepts that are part of those programs, such as condition ratings, can be used as building blocks for a vigorous performance measurement program across operations and maintenance.

Adams (2011) seeks to link maintenance costs and conditions — in an environment with increasing maintenance needs and limited funds — to identify how tradeoffs affect transportation systems. While such an approach would ideally illustrate the relationships between investments in certain features and conditions, the lack of data over a long period of time (three years across three states; Ohio, Wisconsin, and Michigan), and lack of precision regarding where maintenance was performed and what activities were done, leaves a great deal of ambiguity over the ability to relate expenditures and conditions. Tying maintenance activities and costs in a more precise manner is required to evaluate the impacts of spending decisions. While Michigan and Ohio measured maintenance condition by rating sufficiency in several areas and deficiency standards and counts respectively, Wisconsin used thresholds across maintenance features. These thresholds had set measures to indicate a backlog for a particular maintenance element. Using a similar threshold type approach could help set maintenance performance measures either as a minimum standard for service and/or a targeted level of service.

A key component of maintenance activities at many agencies is snow and ice removal. However, winter maintenance activities involve complex responses with performance affected by a number of factors, many of those outside of the agency's control (ICF et al. 2019). Additionally, increases in data collection and improvements in technology have let agencies better monitor and gauge their performance during snow and ice events. As part of NCHRP 889, a survey of state and local agencies reported a number of measures used to assess snow and ice performance (p. 11):

- Time to bare pavement

- Time to wet pavement
- Time to return to near normal
- Time to provide one-wheel track
- Friction
- Level of service
- Travel speed
- Customer satisfaction
- Crashes per vehicle miles
- Traffic volumes during storms
- Time to traffic-normal
- Fuel usage
- Lane miles (ln-mi, or ln-km) plowed
- Personnel hours
- Overtime hours
- Tons of materials used
- Amount of equipment deployment
- Miles (km) traveled – plow down
- Cost of operations (ln-mi)
- Percentage of salt spreaders calibrated

The report identifies core performance measures across three categories: mobility, safety, and sustainability. Mobility measures include level of service, recovery, and reliability; safety measures include injuries and fatalities; and sustainability measures include efficiency, customer satisfaction, and environmental. If agencies embark on developing snow and ice performance measures, it is important to understand that no one measure is entirely representative of snow and ice response because there are many measures that may not be controllable by the agency either fully or partially. When devising performance measures it is critical to focus on the data that are available to feed performance measures, remember that subjectivity is allowable, choose measures that can be understood internally and externally, and ensure that measures can be used in the decision-making process (ICF et al. 2019). Storm severity indices can help contextualize performance based factors unique to the individual storm prompting winter maintenance operations.

Customer-driven maintenance benchmarking is another method focused on results that are of most importance to the agency's customers — "Customer-driven benchmarking involves assessing, adopting, and improving upon "best" practices that have been shown through measurement to lead to higher levels of performance—better products and services to customers" (Hyman 2004, p. 8). Hyman (2004) identifies four measure for customer-driven maintenance benchmarking: outcomes, outputs, resources, and hardship factors, which are things outside the agency's control such as weather (Hyman 2004). Figure 2.3 illustrates steps for establishing maintenance benchmarking (Hyman 2004, Figure 1, p. 7).

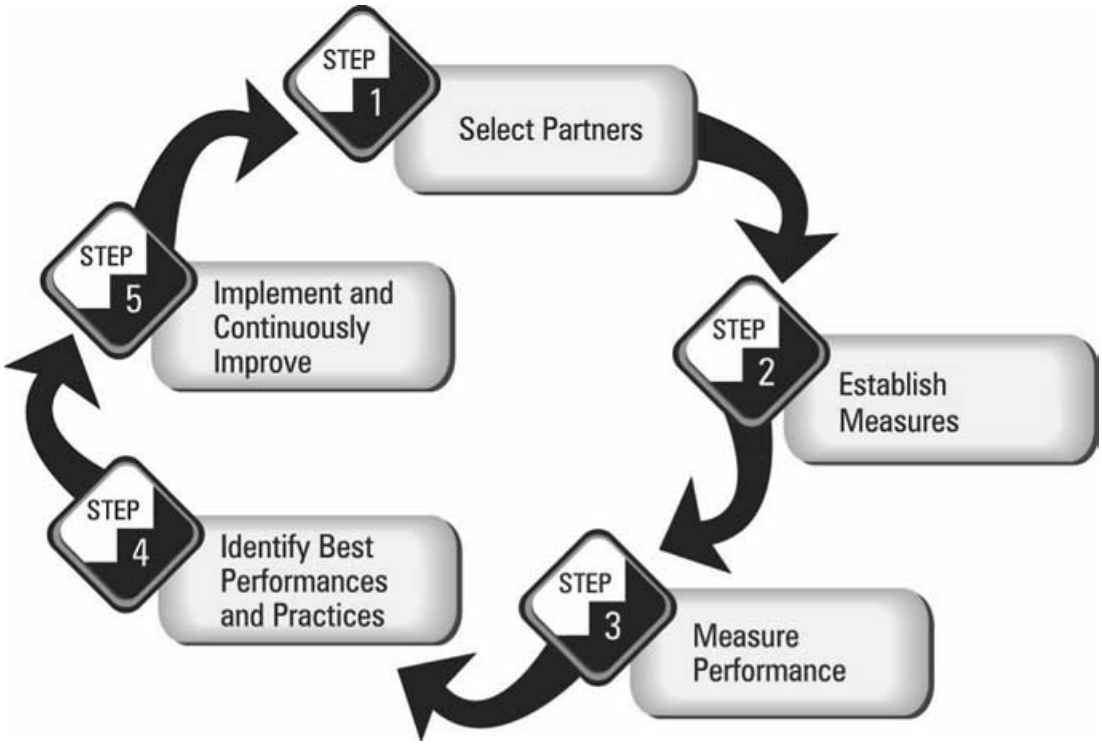



**Figure 2.3** Benchmarking Steps

Benchmarking is a continuous improvement process, where customer expectations can be meet and then exceeded. Leadership, culture, and agreement on the measures being used are prerequisites for starting a benchmarking program. As a way of measuring performance, it allows organizations to make quick comparisons to peers, enables learning from successes and failures, and specifies what customers are receiving and what future targets may be. It may differ from measuring how many potholes are filled versus customer perception of the overall smoothness of the roads. Common customer-based measures include items such as pavement surfaces, signs, markings, shoulders, drainage, and snow and ice removal. As part of the process it is important to identify peers, verify their comparability and ability to share data and use commensurate measures if necessary, and ascertain best practices and integrate them into maintenance activities. Cost and ease of implementation are considerations in any review of potential best practices.

Tsang et al. (1999) review four approaches to maintenance performance measures: balanced scorecard, value-based performance measures, system audits, and performance analysis of operational efficiency. They are defined as follows (p. 691):

> The value-based performance measure evaluates the impact of maintenance activities on the future value of the organization. The Balanced Scorecard (BSC) provides a framework for translating strategy into operational measures that collectively capture the critical requirements for sustaining the organization's success. System audits are the tool for measuring organizational culture, which in turn determines the appropriate approach to the organization of maintenance functions. The operational efficiency of an organization's maintenance function can be benchmarked with those of its counterparts in other organizations by using Data Envelopment Analysis (DEA).

Campbell (1985) classifies common maintenance performance measures into those that measure equipment performance (e.g., reliability), cost performance (e.g., labor costs), and process performance (e.g., comparisons of scheduled versus unscheduled work). Dwight (1994) proposes a hierarchical way to classify performance measures depending on how they impact the business, with levels focused on those impacting the bottom line, instant

measures, system audits, and time-related work. With performance measures it is useful to measure both the outcome through targeting investments and overall output (Cambridge Systematics 2000).

Outsourcing maintenance activities requires using objective performance measures to judge if the services contracted are completed in a manner that meets expectations (Capers 2014). Several factors identified before outsourcing can occur are also relevant in the context of performance measures: having a comprehensive inventory of assets, analysis of asset conditions, documentation of current procedures and performance, and evaluations for potential contractors. A scan of management practices and their use in determining funding levels for maintenance activities also veered toward a performance measurement and management approach (McConnell et al. 2016). Agency culture among organizations that have embraced performance management is characterized by complete buy-in, the ability to explain the mission and priorities of the agency, stakeholders involvement, accountability, and data-driven funding decisions, among others. Performance measures are an important component of efforts to link investment decision with outcomes, managing within budget constraints, and recognizing that any measures/objectives should be realistic given funding (and resource) levels. Confidence in what is being measured directly correlates with how much data are being collected and used in the performance management process. Random sampling is also recommended to ensure that the some samples do not receive more attention than others (Yurek et al. 2012). McConnell et al. (2016) put forth recommendations for transportation agencies to build a robust performance management program:

- Establish performance measures that foster a performance-centered agency culture and build and maintain strong relationships with elected officials
- Develop goals that are driven by the customer, but that are also achievable and help promote accountability
- National guidance on data quality is useful (lacking this, having robust quality management and governance in place is necessary)

Barriers to implementation often exist despite the ample documentation of best practices and recommendations. These include (1) an evolving agency approach, (2) lack of resources to fund or support performance measurement, and (3) state government as a whole has not adopted or embraced performance measures (Markow 2012). Ongoing challenges to performance measurement in the early 2000s were finding agreement on terminology, developing measures for freight and modal comparisons, gathering feedback from external stakeholders aside from the travelling public, setting realistic targets, improving travel time and congestion-related measures, and improving the link between performance measures and employee performance evaluation (Poister 2005).

Setting level of service targets helps build upon maintenance quality assurance programs (Adams et al. 2014). The process involves preparing to set targets, setting targets, and then managing them with several underlying themes such as establishing measures and a baseline when preparing, prioritization and attainability when setting, and risk management and communication while managing (Figure 2.4) (Adams et al. 2014, Figure 1, p.2).

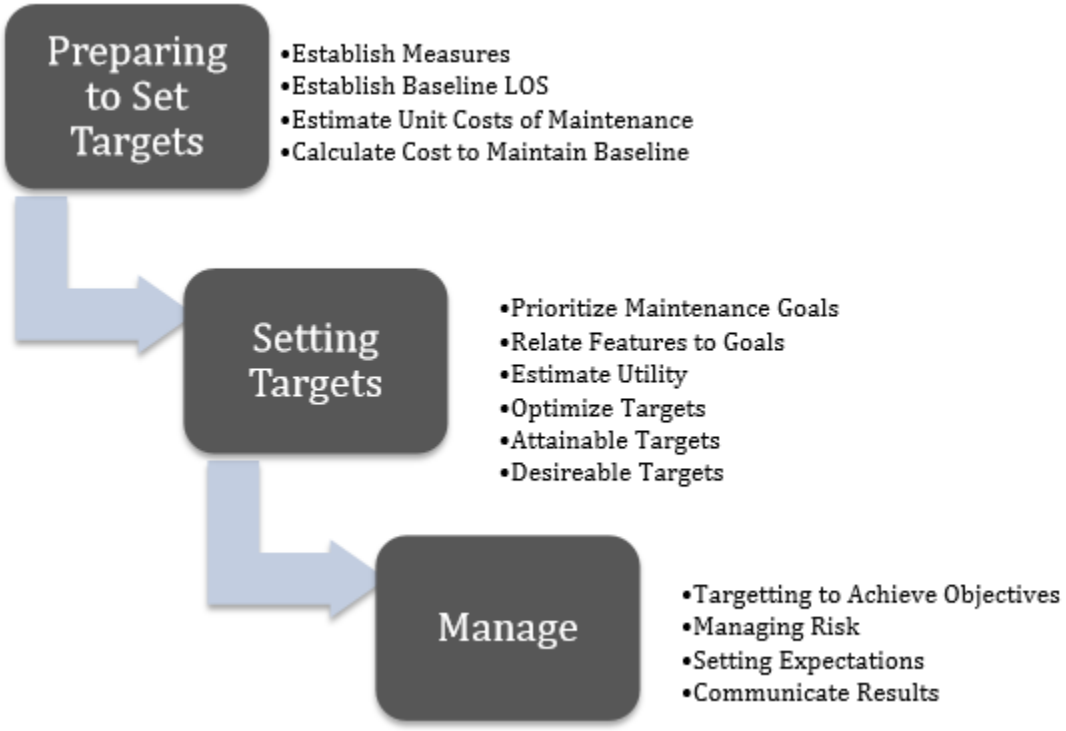



**Figure 2.4** Process for Determining Maintenance Level of Service Performance Measures

Adams et al. focus on what they term highway features — assets and activities that can be measured. Using LOS instills clarity and consistency in the process. Agencies can evaluate level of service using a pass-fail rating, a rating scale (e.g., A, B, C), or a hybrid approach (Yurek et al. 2012). Ratings may be characterized as guidance or desired conditions rather than performance standards. Budget allocations and the limitations they impose on achieving targets also help differentiate between what is achievable and what is desired, which may be determined through different approaches. Similarly, using a risk-based approach to managing maintenance needs is another method of ordering priorities within a LOS framework. If nothing else, setting LOS targets may have organizational benefits such as striving to exceed past performance, empowering employees, ensuring consistency, promoting accountability, and keeping a focus on continuous improvement. Turning toward a more customer-oriented approach to performance measurement helps focus on the maintenance features that are most consequential to the public (Yurek et al. 2012). Dye et al. (2010), develop an approach to measuring LOS on interstates with templates that include goals or outcomes and information about the measure, the asset being measured, and indicators of performance, among others. State of the practice indicated that many common measures are in place, such as pavement (Table 2.1) Other assets and features they review include structures, drainage, roadside, traffic control, mobility, and safety.

**Table 2.1** Pavement State of the Practice

| Asset Class | Asset Elements | Level of Service | | |
|---|---|---|---|---|
| | | Condition | Indicator | Measure |
| Pavement | Travel Lanes: Functional/ Structural | Ride quality/ structural capacity | International Roughness Index, rutting, faulting, fatigue cracking, and transverse cracking | Mean Roughness Index, average rut depth, average fault, % fatigue type cracking, and length of transverse cracking (ft/mi) |
| | Ramps: Functional/ Structural | Ride quality/ structural capacity | International Roughness Index, rutting, faulting, fatigue cracking, and transverse cracking | Mean Roughness Index, average rut depth, average fault, % fatigue type cracking, and length of transverse cracking (ft/mi) |
| | Shoulders | Functioning as designed | Adequate/inadequate, potholes, edge raveling | Extent of shoulders inadequate (percent) |

The entire LOS template can be seen in Table 4.1 of Dye et al. (2010, pp. 21- 28). To illustrate the template and its components, part of the table focused on bridges is reproduced as Table 2.2. Reporting on LOS can be as simple as a report card format with grades based on thresholds in the template. Presenting rating information in an easy-to-understand format can help communication, improve decision making about resources, and establish a level of accountability.

**Table 2.2** Interstate Level of Service Template

| Asset Class | Element | Definition | Indicators | Measure | Level of Service Thresholds | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | A | B | C | D | F |
| Bridges | Deck Condition | This element applies to the riding surface of the bridge where live loads are directly applied (NBI Item No. 58). | Cracking, spalling, holes, or other signs of deterioration. | Average NBI condition rating | 9.0 - 7.0 | 6.9 - 6.0 | 5.9 - 5.0 | 4.9 - 4.0 | < 4.0 |
| | Deck Geometry | This element refers to the curb-to-curb bridge roadway width and the minimum vertical clearance over the bridge roadway (NBI Item No. 68). | Horizontal clearances less than travelway width, or vertical clearances less than 16 ft. | Average NBI condition rating | 9.0 - 8.0 | 7.9 - 6.0 | 5.9 - 4.0 | 3.9 - 2.0 | < 2.0 |
| | Superstructure Condition | This element refers to that component of the bridge that supports the deck, as well as the loads applied to the deck (NBI Item 59). | Section loss or fatigue cracks in steel, shear cracks in concrete, or other signs of deterioration in structural elements. | Average NBI condition rating | 9.0 - 7.0 | 6.9 - 6.0 | 5.9 - 5.0 | 4.9 - 4.0 | < 4.0 |
| | Substructure Condition | This element refers to all the components of the bridge which support the superstructure and transfer the load to the foundation (NBI Item No. 60). | Section loss or fatigue cracks in steel, shear cracks in concrete, scouring under foundations, or other signs of deterioration in structural elements. | Average NBI condition rating | 9.0 - 7.0 | 6.9 - 6.0 | 5.9 - 5.0 | 4.9 - 4.0 | < 4.0 |
| | Under-Clearances, Vertical and Horizontal | This element refers to the minimum vertical and horizontal clearances of the through roadway under the structure (NBI Item No. 69). (Note that clearances | Horizontal clearances less than travelway width, or vertical clearances less than 16 ft. | Average NBI condition rating | 9.0 - 8.0 | 7.9 - 6.0 | 5.9 - 4.0 | 3.9 - 2.0 | < 2.0 |

Interstate performance measures are explored through an asset management framework in NCHRP Report 632 (Cambridge Systematics et al. 2009). A process for identifying performance measures is detailed. It consists of five steps: reviewing existing measures, assessing needs, defining selection criteria, applying those criteria, and finalizing

the selected measures. The report recommends a set of core interstate performance measures (Table 2.3) (Cambridge Systematics et al. 2009, p. 12) in addition to recommended supplementary measures. Reporting should include at least a prior year for comparison, and if data are available up to 10 years.

**Table 2.3** Interstate Asset Management Performance Measures

| Category | Asset Type | Measure Type | Measure |
|---|---|---|---|
| Preservation | Pavement | Structural Adequacy | Present Serviceability Rating (PSR) or an agency's pavement condition index |
| | | Ride Quality | International Roughness Index (IRI) |
| | Bridges | Structural Deficiency | Percent classified as Structurally Deficient (SD), weighted by deck area |
| | Signs | Asset Performance | Percent functioning as intended |
| | Pavement Markings/ Delineators | Asset Performance | Percent functioning as intended |
| | Guardrails | Asset Performance | Percent functioning as intended |
| Mobility | | Travel Time | Travel time index |
| | | Delay | Delay per vehicle in hours |
| Safety | | Crash Rate | Number of crashes expressed as number per year and per million vehicle miles traveled (VMT) |
| | | Fatality Rate | Number of fatalities expressed as number per year and per VMT |
| Environment | | Agency-specific report card of environmental milestones | Pass/fail indication for each measure |

NCHRP 551 reviews asset management performance measures (Cambridge Systematics et al. 2006).[5] Examples are shown in Table 2.4.

[5] See a list of guidelines for asset management performance measures in Appendix A.

**Table 2.4** Asset Management Performance Measures

| Measure Category | Example Measures | Comments |
|---|---|---|
| Preservation of Assets | Pavement condition index<br>Bridge health index<br>Remaining life<br>Debt index (ratio of deterioration or lost value to replacement value) | Condition and remaining life measures can be expressed as averages or distributions (e.g., percent of system length or VMT on roads in good, fair, and poor condition). |
| Mobility and Accessibility | Amount of congested travel (person-miles or VMT under congested conditions)<br>Travel time index (ratio of peak travel time to free-flow travel time)<br>Average travel time between major origins and destinations, by mode<br>Average shipment cost between selected origins and destinations | Care must be taken to distinguish results of agency actions from changes due to growth patterns, fuel prices and other factors. This can be accomplished through use of modeling tools, supplemental socioeconomic and traffic monitoring data, and well-designed before-after studies. |
| Operations and Maintenance | Traffic signal malfunction rate<br>Average incident clearance time<br>Time interval after precipitation stops to restore road conditions to defined standard<br>Sign and pavement marking retroreflectivity<br>Customer satisfaction rating for different maintenance elements | Maintenance level of service approaches can be used to relate achievement of different service levels to budget levels by category of work. |
| Safety | Serious crashes per million VMT<br>Fatalities per 100 million VMT<br>Number of work zone crashes<br>Hazard index (based on crash incidence and severity rates)<br>Backlog ($) of identified cost-effective safety countermeasures to address high-crash locations | Use of the fatality rate measure is recommended for consistency with the U.S. DOT's national performance target to reduce fatalities to 1.0 per million VMT. |

VMT = vehicle-miles traveled

Shaw (2003) documents a set of performance measures generally used to measure the operational effectiveness of highway systems based on a survey and Lomax et al.'s (2001) Texas Transportation Institute report on urban mobility. Table 5 reproduces performance measures documented in Shaw (2003); measures taken from Lomax et al. are followed by TTI in parentheses. One area of emphasis Shaw notes not based on an established program is travel time reliability measures such as Jackson et al.'s (2000) recommendation for reliability performance measures for Florida.[6]

[6] Three components: travel time, expected travel time, acceptable additional time.

**Table 2.5** Operational Effectiveness Performance Measures

| | |
|---|---|
| Commercial vehicle safety violations | Roadway congestion index (TTI) |
| Congestion costs per capita (TTI) | Security for highway and transit |
| Congestion costs per eligible driver (TTI) | Speed |
| Delay caused by incidents | Toll revenue |
| Delay per capita (TTI) | Traffic volume |
| Delay per eligible driver (TTI) | Travel costs |
| Density | Travel rate index (TTI) |
| Duration of congestion | Travel time |
| Evacuation clearance time | Travel time reliability |
| Incidents | Vehicle-miles travelled |
| Level of service | Vehicle occupancy |
| Percent of highway system congested | Wasted fuel per capita (TTI) |
| Percent of travel congested | Waster fuel per eligible driver (TTI) |
| Rail crossing incidents | Weather-related traffic incidents |
| Recurring delay | |
| Response time to weather-related incidents | |

Shaw reports the number of survey responses for many of the measures in Table 2.5 (Table 6, p. 22) with the top three identified most frequently by survey respondents being LOS, traffic volume, and vehicle miles travelled. Other areas of development for performance measures are planning with a multimodal approach (Meyer 1995; Cambridge Systematics et al. 1998) and transportation improvements (Turner et al. 1996).

Margiotta et al. (2007) put forth 12 principles for monitoring freeway performance along with a set of recommended core and supplemental measures. They differentiate measures that are activity-based from those that are quality of service based. Activity-based measures are an output measure and quality-based measures evaluate outcomes. The 12 principles of monitoring include tenets such as communication, continuity in measures, and measure what can be measured and model the rest. Core performance measures are grouped by categories including designations for whether a measure is activity- or quality-based (Table 2.6).

**Table 2.6** Core Freeway Performance Measures

| **Congestion Conditions (Quality of Service)** | |
|---|---|
| Travel time | The average time consumed by vehicles traversing a fixed distance of freeway |
| Travel time index | The ratio of the actual travel rate to the ideal travel rate |
| Total delay, vehicles | The excess travel time used on a trip, facility, or freeway segment beyond what would occur under ideal conditions |
| Total delay, persons | The excess travel time used on a trip, facility, or freeway segment beyond what would occur under ideal condition |
| Delay per vehicle | Total freeway delay divided by the number of vehicles using the freeway |
| Spatial extent of Congestion No. 1 | Percent of Freeway VMT with Average Section Speeds <50 mph |
| Spatial extent of Congestion No. 2 | Percent of Freeway VMT with Average Section Speeds <30 mph |
| Temporal extent of Congestion No. 1 | Percent of Day with Average Freeway Section Speeds <50 mph |
| Temporal extent of Congestion No. 2 | Percent of Day with Average Freeway Section Speeds <30 mph |
| Density | Number of vehicles occupying a length of freeway |
| **Reliability (Quality of Service)** | |
| Buffer index | The difference between the 95th percentile travel time and the average travel time, normalized by the average travel time |
| Planning time index | The 95th Percentile Travel Time Index |

| | |
|---|---|
| **Capacity Bottlenecks (Activity)** | |
| Geometric Deficiencies Related to Traffic Flow (Potential Bottlenecks | Count of potential bottleneck locations by type |
| Major Traffic-Influencing Bottlenecks | Count of locations that are the primary cause of traffic flow breakdown on a highway section, by type |
| **Throughput (Quality of Service)** | |
| Throughput- vehicle | Number of vehicles traversing a freeway in vehicles |
| Throughput- persons | Number of persons traversing a freeway |
| Vehicle-miles of travel | The product of the number of vehicles traveling over a length of freeway, times the length of the freeway |
| Truck vehicle-miles of travel | The product of the number of trucks traveling over a length of freeway, times the length of the freeway |
| Lost Highway Productivity | Lost capacity due to flow breakdown – the difference between measured volumes on a freeway segment under congested flow versus the maximum capacity for that segment |
| **Customer Satisfaction (Quality of Service)** | |
| Worst aspect of Freeway Congestion | Defined by question |
| Satisfaction with Time to Make Long Distance Trips Using Freeway | Defined by question |
| **Safety (Quality of Service)** | |
| Total Crashes | Freeway crashes as defined by the State, i.e., those for which a police accident report form is generated |
| Fatal crashes | Freeway crashes as defined by the State, i.e., those for which a police accident report form is generated, where at least one fatality occurred |
| Overall crash rate | Total freeway crashes divided by freeway VMT for the time period considered |
| Fatality crash rate | Total freeway fatal crashes divided by freeway VMT for the time period considered |
| Secondary crashes | A police-reported crash that occurs in the presence of an earlier crash |
| Ride Quality (Quality of Service) | |
| Present Serviceability Rating | The general indicator of ride quality on pavement surfaces |
| International Roughness Index (IRI) | Cumulative deviation from a smooth surface |
| Environmental (Quality of Service) | |
| Nitrous Oxides (NOx) Emission Rate | Modeled NOx attributable to freeways divided by freeway VMT |
| Volatile Organic Compound (VOC) Emission Rate | Modeled VOC attributable to freeways divided by freeway VMT |
| Carbon Monoxide (CO) Emission Rate | Modeled CO attributable to freeways divided by freeway VMT |
| Fuel Consumption per VMT | Modeled gallons of fuel consumed on a freeway divided by freeway VMT |
| **Incident Characteristics (Activity)** | |
| No. of Incidents by Type and Extent of Blockage | Self-explanatory |
| Incident Duration | The time elapsed from the notification of an incident to when the last responder has left the incident scene |
| Blockage Duration | The time elapsed from the notification of an incident to when all evidence of the incident (including responders' vehicles) has been removed from the travel lanes |

| | |
|---|---|
| Lane-Hours loss due to incidents | The number of whole or partial freeway lanes blocked by the incident and its responders, multiplied by the number of hours the lanes are blocked |
| **Work-Zone (Activity)** | |
| No. of Work Zones by Type of Activity | The underlying reason why the work zone was initiated: 1) resurfacing only; 2) RRR; 3) lane addition w/o interchanges; 4) lane additions w/interchanges; 5) minor crosssection; 6) grade flattening; 7) curve flattening; 8) bridge deck; 9) bridge superstructure; 10) bridge replacement; and 11) sign-related |
| Lane-Hours Lost Due to Work Zones | The number of whole or partial freeway lanes blocked by the work zone, multiplied by the number of hours the lanes are blocked |
| Average Work Zone Duration by Type of Activity | The elapsed time that work zone activities are in effect |
| Lane-Miles Lost Due to Work Zones | The number of whole or partial freeway lanes blocked by the work zone, multiplied by the length of the work zone |
| Weather (Activity) | |
| Extent of highways affected by snow and ice | Highway centerline mileage under the influence of uncleared snow or ice multiplied by the length of time of the influence |
| Extent of highways affected by rain | Highway centerline mileage under the influence of rain multiplied by the length of time of the influence |
| Extent of highways affected by fog | Highway centerline mileage under the influence of fog multiplied by the length of time of the influence |
| **Operational Efficiency (Activity)** | |
| Percent Freeway Directional Miles with (traffic sensors, surveillance cameras, DMS, service patrol coverage) | One measure for each type of equipment deployed in an area |
| Percent of Equipment (DMS, surveillance cameras, traffic sensors, ramp meters, RWIS) in “Good” or Better Condition | One measure for each type of equipment deployed in an area |
| Percent of total device days out-of-service (by type of device) | One measure for each type of equipment deployed in an area |
| Service patrol assists | Self-explanatory |

Crossett and Hines (2007) analyze construction practices of states with consistent project delivery. This was the first in a series of reports sponsored by the American Association of State Highway and Transportation Officials (AASHTO). Subsequent studies covered pavement smoothness (Harrison et al. 2008), safety (Spy Pond Partners and Kim 2009), and bridge condition (Spy Pond Partners and Arora and Associates 2010), among others. Perhaps the most relevant to maintenance and operations is the initial analysis of construction approaches followed by that of pavement smoothness and bridge conditions. Crossett and Hines’s detailed analysis from 2001 to 2005 sought to identify good practices of states that consistently deliver projects on time and on budget. These two measures, while very basic, can be used as internal measures of project delivery success and external measures to compare performance with peers. KYTC ranked number one in cost performance and was a strong schedule performer as well. Interviews with top performing DOTs yielded several best practices for cost and schedule performance (Table 2.7) (Crossett and Hines 2007, p. 6-10).

**Table 2.7** Good Practices for Project Delivery Cost and Schedule

| Cost | Schedule |
|---|---|
| Poor cost performance in the past helps motivate DOTs | Gather input from project managers on schedule estimates |
| Managers need to provide leadership | Focus on recruitment and retention of experienced staff |
| Focus on setting more accurate cost estimates | Advanced Geo-technical survey techniques |
| Measure budget performance at least monthly or quarterly | Use accurate unit production times |
| Track causes of cost overruns | Conduct constructability reviews |
| Utilize production meetings for accountability | Actual measurement of on-schedule performance |
| Measure performance during the project, don't wait until it is finished | Track and monitor causes of schedule delay |
| Link performance to pay, such as bonuses | Generate monthly progress reports for staff accountability |
| Have reporting/review requirements for cost overrun targets | Pay for utility relocation |
| Use value engineering | Utilize sliding windows for contractors to finish projects |
| Communicate with contractors and hold them accountable | Hold mandatory pre-bid meetings for large projects |
| Use a team-based project development process | Gather contractor input on specifications for testing |
| | Provide contractor incentives for early completion |
| | Keep contractors accountable |
| | Pay attention to Right of Way, Permits, and Utilities |

Crossett and Hines (2007) also analyze several years of projects to determine what percentage finished with a final cost at or below the original award amount and what fraction were completed on or before the original scheduled completion date. Agencies had room to improve on these measures — 46% of projects were completed within the cost parameter and 53% on schedule. They note this is more of an issue for larger projects. Projects costing more than $5 million scored 18% on cost, although the overall magnitude of the cost overruns was under 10%; 35% were on schedule. Overall, state DOTs that perform well on cost and schedule do so consistently and with significant margins over the lowest performing states. In terms of pavement smoothness, a number of agency and contractor practices yield positive results (Harrison et al. 2008). On the agency side, key performance factors include having a strong performance management program with pavement condition performance targets, building relationships with contractors, and having a comprehensive pavement management approach to building, maintaining, and rehabilitation. On the contractor side, materials, testing and adjustments, and equipment deployment were noted. For performance measurement, several of best practices on both the agency and contractor sides can be measured and provide performance insights. Spy Pond Partners and Arora and Associates' (2010) review of state bridge conditions and practices that yield better performance also revealed several themes that contain related practices. One theme was making a case for investment through performance measures, benchmarking bridge conditions, and then setting targets and identifying funding levels needed to achieve those targets. Emphasizing preservation through monitoring, inspection, and programs centered on key preservation approaches and timing was another relevant theme.

Within the umbrella of performance measurement, benchmarking is another approach for gauging performance. Benchmarking, or using comparable measures and practices to compare performance with similar agencies or organizations, has as its goal improving overall performance (Crossett et al. 2019). Steps to establish a benchmarking process are elucidated in the guidebook as well (p. 25):

1. Set the stage: identify areas of focus and pull together a team, identify objectives
2. Select peer agencies: establish criteria to select peers

3. Define the approach: select measures and define them, identify data sources
4. Obtain the data: check national data sources and peer data sources
5. Analyze data: ensure data have been checked for quality; statistical significance is useful
6. Identify noteworthy practices: exchange experiences and information with peers
7. Communicate results: use effective communications to present results
8. Recommend improvements: use results to search for ways to improve performance
9. Repeat the process: use benchmarking as part of a continuous improvement process

Successful benchmarking processes are characterized by leadership, the use of comparable measures and judicious choice of peers, ensuring data quality, and displaying an organizational commitment to continuous improvement. When implementing a benchmarking process agencies should rely on subject-matter experts who are more adept at identifying the right peers and measures.

# Chapter 3 Federal and State Review

## 3.1 Federal Background

Historically, many state DOTs have used different metrics to quantify the performance and preservation of infrastructure assets. But arguably the current era of performance measurement and management was ushered in by MAP-21 and the FAST Act. Before MAP-21 was signed into law, state DOTs were not obligatied to document how transportation programs supported performance outcomes at the national level. Nor were agencies legally bound to measure condition or performance, establish targets for system performance, or adhere to uniform reporting standards the Federal Highway Administration (FHWA) could use to assess the entire US transportation system. MAP-21 put forward new requirements for performance management with the objective of achieving goals related to safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, and project delivery timelines. MAP-21's emphasis on performance management focuses on increasing the accountability and transparency of the Federal-aid highway program and fostering more informed (and better) investments and decision making. A key objective of performance management is helping state DOTs and MPOs use federal transportation dollars for only the most efficient investments. The FHWA expects agencies to use performance measurement data to improve transportation planning and programming.

While MAP-21 laid the groundwork for better performance management and reporting, the FAST Act contains two modifications. First, it requires state DOTs to implement and document remedial actions if they fail to make significant progress toward performance benchmarks during a biennial reporting period. Second, it authorizes penalties for agencies (under 23 USC 119(f)(1)(A)) if the FHWA deems interstate pavement conditions do not meet minimum condition thresholds for the most recent year. Through the federal rulemaking process, FHWA established performance measures state DOTs are required to calculate. In 2016 and 2017, the agency issued three rules: 1) Safety Performance Management (PM) Rule, 2) Infrastructure PM Rule, and 3) System Performance PM (*sic*) Rule. Table 5.1 lists the performance measures falling under each rule and the transportation assets covered by each. The FHWA houses reporting for these measures on its transportation performance management website: https://www.fhwa.dot.gov/tpm/reporting/state/. KYTC generated a dashboard to comply with the MAP-21 requirements, although the latest reported data is from 2012.[7]

**Table 3.1** FHWA-Mandated Performance Measures

| **Safety PM Final Rule** | | |
|---|---|---|
| **23 CFR Part 490 Section** | **Performance Measure** | **Target Assets** |
| 490.207(a)(1) | Number of Fatalities | All public roads |
| 490.207(a)(2) | Rate of Fatalities | All public roads |
| 490.207(a)(3) | Number of Serious Injuries | All public roads |
| 490.207(a)(4) | Rate of Serious Injuries | All public roads |
| 490.207(a)(5) | Number of Non-Motorized Fatalities and Non-Motorized Serious Injuries | All public roads |
| **Infrastructure PM Final Rule** | | |
| **23 CFR Part 490 Section** | **Performance Measure** | **Target Assets** |
| 490.307(a)(1) | Percentage of Pavements of the Interstate System in Good Condition | Interstate System |
| 490.307(a)(2) | Percentage of Pavements of the Interstate System in Poor Condition | Interstate System |
| 490.307(a)(3) | Percentage of Pavements of the non-Interstate NHS in Good Condition | Non-Interstate NHS |
| 490.307(a)(4) | Percentage of Pavements of the non-Interstate NHS in Poor Condition | Non-Interstate NHS |
| 490.407(c)(1) | Percentage of NHS Bridges Classified in Good Condition | NHS |

[7] https://datamart.kytc.ky.gov/kytcmap21_M.asp

| | | |
|---|---|---|
| 490.407(c)(2) | Percentage of NHS Bridges Classified in Poor Condition | NHS |
| **System Performance PM Final Rule** | | |
| **23 CFR Part 490 Section** | **Performance Measure** | **Target Assets** |
| 490.507(a)(2) | Percent of Person-Miles Traveled on Interstate That Are Reliable | Interstate System |
| 490.507(a)(2) | Percent of Person-Miles Traveled on non- Interstate NHS That Are Reliable | Non-Interstate NHS |
| 490.507(b) | Percent Change in Tailpipe $CO_2$ Emissions on the NHS cf. CY 2017 Levels | NHS |
| 490.607 | Truck Travel Time Reliability Index | Interstate System |
| 490.707(a) | Annual Hours of Peak Hour Excessive Delay per Capita | NHS in urban areas w/Populations > 1 million for first performance period<br><br>NHS in urban areas w/populations > 200,000 for the second and all other performance periods |
| 490.707(b) | Percent of Non-SOV Travel | NHS in urban areas w/Populations > 1 million for first performance period<br><br>NHS in urban areas w/populations > 200,000 for the second and all other performance periods |
| 490.807 | Total Emissions Reduction | All projects financed via 23 USC 149 CMAQ program in areas that are non-attainment or maintenance for ozone, carbon monoxide, or particulate matter |

In general, the purpose of these rules is to establish performance thresholds. For example, the Safety PM Final Rule specifies measures that state DOTs will use to execute the Highway Safety Improvement Program, processes that can be used to establish safety targets, methods for determining whether significant progress is being made, and the reporting process. Measures are calculated based on a five-year rolling average. Under the rule, an agency must meet or make significant progress toward meeting four out of five safety performance targets. Agencies which do not meet or show evidence of significant progress are required to 1) use a portion of their obligation authority only for HSIP projects and 2) submit an annual implementation plan that describes actions that will be taken to meet targets. Meanwhile, the Infrastructure PM Final Rule requires state DOTs to maintain bridges and pavements at or above a minimum condition level. The System Performance PM Final Rule has several foci, including reliability and environmental sustainability; for these measures, state DOTs were to have established targets by February 2018.

Because collecting data on the 12 performance measures listed in Table 3.2 is not optional for state DOTs (and therefore do not warrant further comment), the rest of this section briefly reviews FHWA resources on

transportation performance management (TPM) and then turns to efforts that have been pursued by individual agencies. The review of state-level practices focuses on metrics not covered by any of the PM Final Rules. The focus is directed toward project management and delivery as well as interesting and novel methods agencies use to represent data (e.g. dashboards, reports). We also include findings from Duncan et al. (2018), who analyzed performance management cultures at several DOTs around the US.

### 3.1.1 FHWA Guidance on Transportation Performance Management

TPM is a strategic approach to investment and policy decision making that leverages system information. FHWA focuses on investment decisions oriented around system improvements to facilitate the transport of goods and safer, more reliable travel for the public (Figure 3.1).


**Figure 3.1** FHWA Transportation Performance Management[8]

TPM is systematically and continuously applied process. This produces information decision makers can use to determine how investment decisions will reverberate across transportation assets or modes. The approach also endeavors to strengthen communication between decision makers, stakeholders, and the public. For TPM to succeed, performance targets and measures should be crafted through synergistic partnerships and leverage high-quality empirical data. TPM also calls for judicious data management and the analysis and communication of findings to internal and external stakeholders. TPM confers several benefits — it gives state DOTs a unifying focus upon which they can base their operations; by reviewing historical performance and projecting future trends, agencies can dedicate resources to areas most in need of attention; life-cycle asset costs are minimized; stakeholders can gauge how changing funding levels will influence performance; agencies have the opportunity to clearly define desired performance outcomes; and facilitation of regulatory compliance. More specifically, TPM is done routinely using data and objective analysis to help provide policymakers with relevant information regarding investment decision and their impacts. It also helps improve communication between policymakers and the public regarding system performance and the methodology behind investment decisions. TPM and Asset Management are also interrelated as FHWA notes:

> Transportation performance management is an approach to managing transportation system performance outcomes. Asset management is the application of this approach to manage the condition of the infrastructure assets that are needed to provide for mobility and safety on the nation's transportation system. In short, asset management is the engine that drives infrastructure performance.[9]

This sentiment is echoed in NCHRP Report 632 which notes that asset management hinges on using data and performance-based decisions, including a risk-based component (Cambridge Systematics et al. 2009). Using performance measures to operationalize policy goals can yield valuable information for strategic management decisions, like those related to resource allocation and obtaining feedback on the effectiveness of programs and

[8] https://www.fhwa.dot.gov/tpm/
[9] https://www.fhwa.dot.gov/tpm/resources/working.cfm

initiatives. Compared to performance measurement, performance management places more emphasis on using performance data to document the effectiveness of decisions and recursively adjust programming where necessary. Figure 3.2 presents the FHWA's TPM framework.

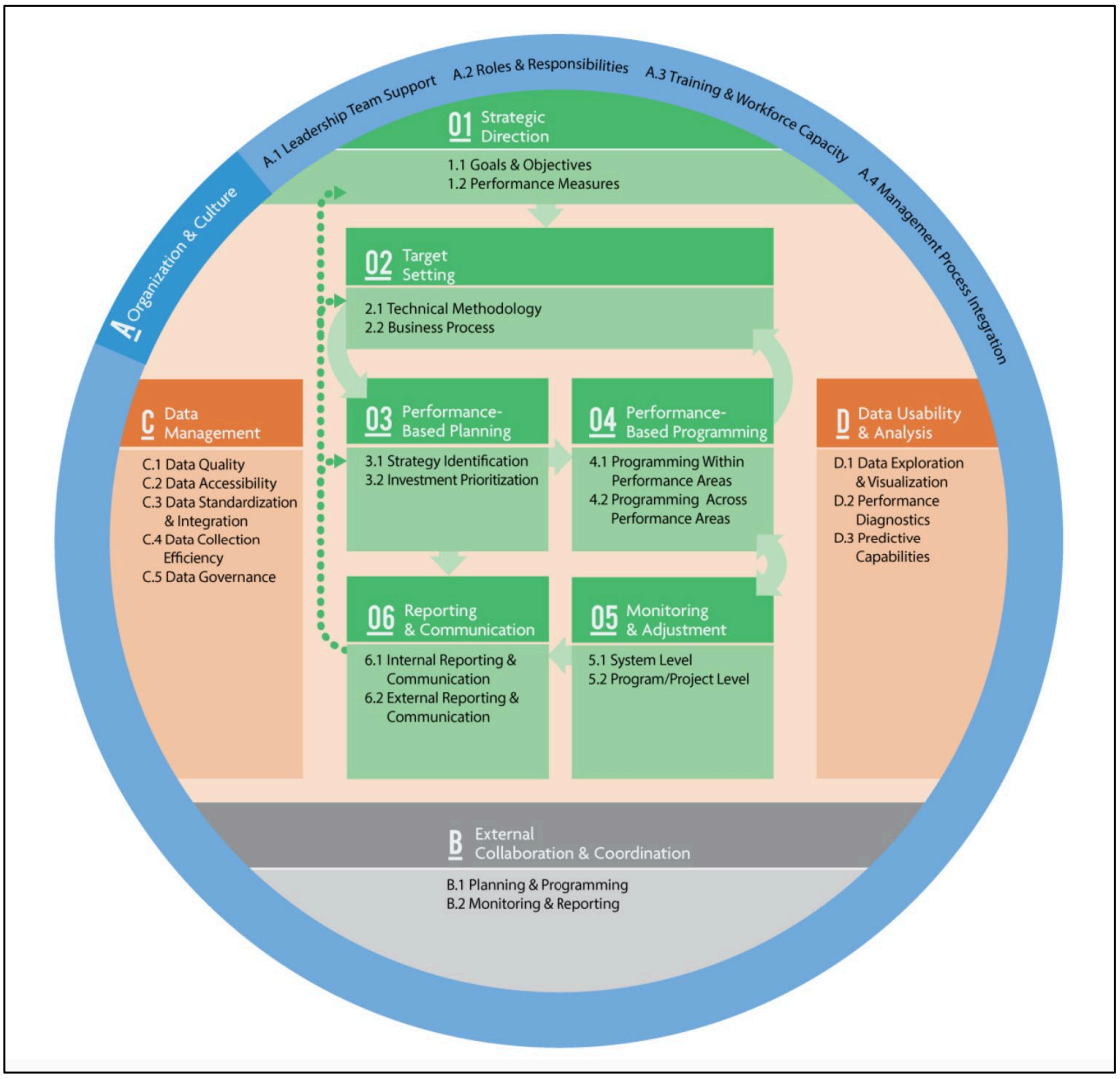



**Figure 3.2** FHWA Transportation Performance Management Framework

In the FHWA's vision, TPM has six principal components — strategic direction, target setting, performance-based planning, performance-based programming, monitoring and adjustment, and reporting and communication. Strategic direction is the foundation upon which a performance management program is built. Its purpose is to establish clear goals and objectives. Knowing these, an agency can reliably evaluate if it is progressing toward its goals. Once the strategic vision has been outlined, targets may be established in light of baseline data, information on possible strategies, resources constraints, and forecasting tools. It is important to show how investment decisions are linked to performance objectives. Equally, quality data are needed to establish targets. It is critical to know what data are available, whether they will continue to be available in the future, and how they can be made usable.

Armed with knowledge of baseline performance, trends, and goals, agencies shift to performance-based planning to develop strategies and priorities for transportation planning. This entails brainstorming strategies to attain hoped-for outcomes and examining tradeoffs involved in alternative investment scenarios. Planning documents articulate how an agency plans to meet specified performance outcomes. Next, programming is accomplished by leveraging

strategies and priorities generated during the planning stage to allocate resources — again, a clear link should be drawn between investments and expected outcomes. Implementing performance-based programming demands that programming be done within and across performance areas (e.g., safety, infrastructure, project delivery). A key consideration during this phase should be funding and resource constraints that affect how funding is applied to projects.

To evaluate whether strategies are succeeding, an agency must institute processes to quantitatively assess actions and outcomes. Performance data are used to measure the effectiveness of decisions and figure out where adjustments are needed to bolster performance. Once an agency begins to monitor outcomes and adjust practices in response, a feedback loop between planning, programming, and target setting emerges. Performance monitoring can also help an agency identify data gaps and determine where more data collection will be helpful. Becoming more acquainted with the dynamic relationship between action and performance helps an agency meet its objectives and explain results to stakeholders. The final dimension of the core TPM framework is reporting and communication. It is incumbent upon an agency to develop techniques for clearly communicating information to a wide range of audiences. Reporting is necessary to increase accountability and transparency and demonstrate that decision making is proceeding in a data-driven manner.

The FHWA also generates state performance dashboards focused on highway safety, infrastructure condition, reliability, and emissions reductions (Table 3.2) Denison et al. (2012) piloted a dashboard of performance metrics across Kentucky that reported on system characteristics, infrastructure, safety, and finances. Within each category there is more detail and additional measures such as pavement in good and poor condition, number and rate of serious injuries, and person-miles traveled among others.

**Table 3.2** FHWA Performance Dashboard

| Category | Performance Measure | Result |
|---|---|---|
| Safety | Fatalities | 737.4 (5 year average) |
| Infrastructure Condition | Bridges in Good Condition | 34.8% |
| Reliability | Truck Travel Time Reliability Index | 1.24 |
| Emissions Reduction | NOx remissions reduced (kg/day; 4 year cumulative) | 33.4 |

Several prerequisites are necessary if a robust performance management program is to succeed. First, an agency must commit to a performance management culture. This happens through buy-in from leadership and employees as well as by establishing structures and processes that facilitate performance management. Processes must be put in place so an agency can work with its partners and stakeholders to plan, set targets, program, share data, and report the outcomes of performance measurement. Third, an agency must be committed to sound data management practices. Lastly, data must be in a usable and accessible format. It is exceedingly difficult to extract information from unorganized data and thus pursue the core activities of performance management.

Having reviewed the core tenets of the TPM framework, we now turn to individual states and the methods they have used to enact performance management and performance measurement initiatives.

## 3.2 State Performance Measures

### 3.2.1 Washington

Since 2001, the Washington DOT (WSDOT) has published the Gray Notebook, a quarterly performance and accountability report. Each issue leads off with an overview of the agency's strategic plan and its statewide transportation policy goals dashboard (Figure 3.3). This dashboard summarizes data on key metrics related to safety, asset preservation, mobility (Figure 3.4) the environment, and project delivery. Mobility measures are fairly straightforward. WSDOT also calculates the benefits of its incident response team, assessing averaging clearance time, the costs of delays, and economic benefits of the program. Key project delivery metrics tracked by the agency include the number of projects completed and percentage completed on time, percentage of projects completed on

budget, and variance in total project costs. Recent issues of the Gray Notebook discuss WSDOT's MAP-21 performance targets and present current data for associated performance metrics along with two- and four-year goals. While some areas receive coverage in each issue, other topics are addressed on a biennial or annual basis. Articles are prepared by subject-matter experts. Table 3.3 lists when and how frequently various topics are addressed.

**Table 3.3** Washington DOT Performance Metrics

| |
|---|
| **Quarterly Dashboards** |
| • Moving Ahead for Progress in the 21st Century (MAP-21), Statewide Transportation Policy Goals |
| **Quarterly Reports** |
| • Capital Project Delivery Programs, Incident Response, Washington State Ferries, WSDOT's Strategic Plan |
| **Quarter 1 (March)** |
| • Active Transportation: Safety, Commercial Vehicle Services, Noise Quality, Passenger Rail (Amtrak Cascades), Safety Rest Areas, Transportation and the Economy, Travel Information, Wetlands Protection |
| **Quarter 2 (June)** |
| • Bridges, Fish Passage Barriers, Freight (Multimodal), General Environmental Permits, Highway, Safety, Inclusion |
| **Quarter 3 (September)** |
| • Active Transportation: Mobility, Aviation, Capital Facilities, Corridor Capacity Report, Ferries Vessels and Terminals, Water Quality |
| **Quarter 4 (December)** |
| • Environmental Compliance, Freight (Rail), Highway Maintenance, Pavement, Practical Solution, Public Transit Safety, Tolling, Worker Safety |

| Statewide policy goal/ WSDOT performance measure | Previous period | Current period | Goal | Goal met | Five-year trend (unless noted) | Desired trend |
|---|---|---|---|---|---|---|
| **Safety** | | | | | | |
| Rate of **traffic fatalities** per 100 million vehicle miles traveled statewide (Annual measure: calendar years 2017 & 2018) | 0.92 | 0.88 | <1.00[1] | ✓ | | ↓ |
| Rate of **recordable incidents** for every 100 full-time WSDOT workers (Annual measure: calendar years 2018 & 2019) | 5.0 | 4.7 | <5.0 | ✓ | | ↓ |
| **Preservation** | | | | | | |
| Percentage of state **highway pavement** in fair or better condition by vehicle miles traveled (Annual measure: calendar years 2017 & 2018) | 91.8% | 91.4% | ≥ 90% | ✓ | | ↑ |
| Percentage of **state bridges** in fair or better condition by bridge deck area (Annual measure: fiscal years 2018 & 2019) | 92.5% | 92.9% | ≥ 90% | ✓ | | ↑ |
| **Mobility[2] (congestion relief)** | | | | | | |
| **Highways**: Vehicle Miles Traveled **(VMT)** on state highways (Annual measure: calendar years 2017 & 2018) | 34.6 billion | 35.4 billion | * | N/A | | Not applicable |
| **Highways**: Average **incident clearance times** for all Incident Response program responses (Calendar quarterly measure: Q1 2019 & Q1 2020) | 12.5 minutes | 13.5 minutes | * | N/A | | ↓ |
| **Ferries**: Percentage of trips departing on time[3] (Fiscal quarterly measure: year to year Q3 FY2019 & Q3 FY2020) | 93.7% | 95.3% | ≥ 95% | ✓ | | ↑ |
| **Rail**: Amtrak Cascades on-time performance[4] (Annual measure: calendar years 2018 & 2019)[5] | 50% | 58% | ≥ 88% | – | | ↑ |
| **Environment** | | | | | | |
| Number of WSDOT **stormwater management facilities** constructed (Annual measure: fiscal years 2018 & 2019) | 78 | 66 | * | N/A | | Not applicable |
| Cumulative number of WSDOT **fish passage improvement projects** constructed (Annual measure: calendar years 2017 & 2018) | 330 | 345 | * | N/A | | ↑ |
| **Stewardship** | | | | | | |
| Cumulative number of Nickel and TPA **projects completed**[6] and **percentage on time**[7] (Biennial quarterly measure: Q2 2019-2021 & Q3 2019-2021, trendline for percentage on time) | 383/ 86% | 383/ 86% | ≥ 90% on time | – | (Five-quarter trend) | ↑ |
| Cumulative number of Nickel and TPA **projects completed**[6] and **percentage on budget**[7] (Biennial quarterly measure: Q2 2019-2021 & Q3 2019-2021, trendline for percentage on budget) | 383/ 91% | 383/ 91% | ≥ 90% on budget | ✓ | (Five-quarter trend) | ↑ |
| Variance of total project costs[4] compared to **budget expectations**[7] (Biennial quarterly measure: Q2 2019-2021 & Q3 2019-2021) | Under budget by 1.5% | Under budget by 1.5% | On or under budget | ✓ | (Five-quarter trend) | Not applicable |

Data source: WSDOT Transportation Safety & Systems Analysis.
Notes: (*) = goal has not been set. Dash (–) = goal was not met in the reporting period. **1** The Statewide Transportation Policy Goal for this performance measure is different than the federal MAP-21 goal for the same measure. **2** Mobility does not yet include goals for people walking/ biking for transportation. **3** Washington State Ferries' on-time departures include any trip recorded by automated tracking as leaving the terminal within 10 minutes of scheduled time. **4** Amtrak Cascades' on-time performance includes any trip arriving within 10 or 15 minutes, depending on the route, of scheduled arrival time. **5** Previous editions of the Gray Notebook reported this measure for the fiscal year. **6** Construction projects only. **7** Projects are on time if they are completed within the quarter planned in the last approved schedule, and on budget if costs are within 5% of the budget set in the last approved state transportation budget.

**Figure 3.3** Washington DOT Statewide Transportation Policy Goals Dashboard in Gray Notebook

| Mobility[2] | | | | | | |
|---|---|---|---|---|---|---|
| **Highways**: Vehicle Miles Traveled **(VMT)** on state highways (Annual measure: calendar years 2018 & 2019) | 35.4 billion | 35.4 billion | * | N/A | | Not applicable |
| **Highways**: Average **incident clearance times** for all Incident Response program responses (Calendar quarterly measure: Q1 2020 & Q1 2021) | 13.5 minutes | 15.8 minutes | * | N/A | | ↓ |
| **Ferries**: Percentage of trips departing on time[3] (Fiscal quarterly measure: Q3 FY2020 & Q3 FY2021) | 95.3% | 92.1% | ≥ 95% | – | | ↑ |
| **Rail**: Amtrak Cascades on-time performance[4] (Annual measure: calendar years 2019 & 2020)[5] | 58% | 62% | ≥ 88% | – | | ↑ |

**Figure 3.4** Washington DOT Gray Notebook Mobility Performance Measures

In addition to the Gray Notebook, WSDOT maintains an online Strategic Plan Dashboard that indicates level of performance for different metrics and notes whether performance is hitting agency targets.[10] WSDOT also has developed a Performance Reporting Gallery that contains Esri Story Maps, which visualize different aspects of system performance (e.g., ferries, Amtrak projects, corridor capacity, and guardrail condition), and maintains a list of projects that have logged change orders in excess of $500,000. Responding to the COVID-19 pandemic, WSDOT built

[10] https://www.wsdot.wa.gov/about/secretary/strategic-plan/dashboard/default.htm

a Multimodal Transportation System Performance Dashboard that captures how the state's multimodal transportation system has been affected by the pandemic.[11] This tool lets users examine trends since March 2020 in areas such as highway traffic, tolling, ferries ridership, transit ridership, passenger rail, and aviation.

### 3.2.2 Texas

The Texas DOT (TxDOT) views performance monitoring and management as an essential component of its planning process and maintains several dashboards which report on whether the agency is achieving performance targets.[12] The main Performance Dashboard site consists of seven dashboards which summarize performance for one or more metrics: Optimize System Performance, Deliver the Right Projects, Promote Safety, Preserve Our Assets, Focus on the Customer, Value our Employees, and Foster Stewardship. Three dashboards present information required by the federal government. However, the other four provide insights into project delivery, customer and employee satisfaction, and stewardship.

Individual dashboards include descriptions of performance metrics and how they are measured, objectives, graphs that chart year-over-year performance, interpretive guidance, and a brief synopsis of why individual metrics are consequential. Table 3.4 lists performance metrics on these dashboards. A few metrics require a little explanation. Two customer-centric measures deal with TxTag, which is a program that drivers can take advantage of to prepay tolls. Data on employee engagement scores are collected biennially by the University of Texas and are used to make workplace improvements and identify strategies to fulfill TxDOT's mission. Under the stewardship category, the agency monitors the amount of federal-contract funding that goes to Disadvantaged Business Enterprises (DBEs) as well as the level of state-contract funding directed toward Historically Underutilized Businesses (HUBs).

**Table 3.4** TxDOT Performance Measures

| **Congestion and Reliability Indices** |
|---|
| • Urban Congestion<br>• Urban Reliability<br>• Rural Reliability<br>• Truck Reliability<br>• Vehicle Miles Traveled<br>• Annual Delay Per Person |
| **Deliver the Right Projects** |
| • Percentage of Highway Infrastructure Contracts Completed on Time<br>• Percentage of Highway Infrastructure Contracts Completed on Budget |
| **Promote Safety** |
| • Annual Fatalities and Fatality Rate<br>• Annual Serious Injuries and Serious Injury Rate<br>• Fatality Emphasis Areas<br>• Employee Injury Rate |
| **Preserve Our Assets** |
| • Percentage of Lane Miles in Good or Better Condition<br>• Bridge Condition Score |
| **Focus on the Customer** |
| • Percentage of Customer Complaint Cases Closed on Time<br>• Customer Complaint Case Type (Top 5)<br>• Average TxTag Call Wait Time<br>• Average TxTag Call Handle Time |
| **Value Our Employees** |

[11] https://www.wsdot.wa.gov/about/covid-19-transportation-report/
[12] http://www.dot.state.tx.us/dashboard/index.htm

| |
|---|
| • Employee Engagement Score |
| **Foster Stewardship** |
| • DBE Attainment<br>• HUB Attainment<br>• Direct Transportation Funding |

More specific information on congestion and reliability indices and how annual delay per person is calculated are detailed on the website along with graphs tracking annual progress. Because these indices pertain to mobility, that background information is included in Table 3.5

**Table 3.5** TxDOT Background on Congestion and Reliability Indices and Annual Delay Per Person

| |
|---|
| Congestion and Reliability Indices Background<br>**Description:** Average traffic congestion and travel time on Texas roadways.<br>**How is it measured?** The optimal value for all indices is 1.0, which means traffic is flowing at the posted speed limit. A score of 1.5 means 30 minutes should be planned for a 20-minute trip during free-flow travel (30 minutes divided by 20 minutes).<br><br>The **Urban Congestion Index** represents the total time that should be allowed to ensure on-time arrival for an average trip (for passenger vehicles and commercial trucks) within urban areas (areas with a population greater than 50,000 people).<br><br>The **Reliability Index** is similar to the Congestion Index. The distinction is that it represents how much total time should be allowed to ensure (with 95 percent probability) an on-time arrival. The Reliability Index is related to three other performance measures:<br>• The Urban Reliability Index is calculated in areas with a population greater than 50,000 people.<br>• The Rural Reliability Index is calculated in areas with fewer than 50,000 people.<br>• The Truck Reliability Index is calculated for urban and rural areas using only commercial trucks.<br><br>**Why these matter?** Transportation affects every aspect of our daily lives. The amount of time we spend in congestion is time spent away from family and friends. Tracking travel times across Texas helps identify priority areas for our projects aimed at reducing the amount of time spent in congestion and improving overall reliability.<br><br>Annual Delay Per Person<br>**Description:** Number of hours of delay per driver per year on Texas roadways.<br><br>**How is it measured?** This measure estimates the annual delay per person in the state. It is the ratio of a) total annual hours of delay for all vehicles on Texas roadways to b) the estimated population of Texas, according to the Texas Demographic Center.<br><br>**Why this matters?** The highway system in Texas serves the growing needs of the traveling public. Hours of delay on Texas roadways incurs time and cost for businesses and the general population. Tracking the delay helps identify areas of improvement for relieving bottlenecks and enhancing the efficiency of the transportation system. |

Source: https://www.dot.state.tx.us/dashboard/optimize-system-performance.htm

TxDOT also maintains a Performance Results Summary dashboard for performance targets set by the Texas Legislature in the General Appropriations Act. Along with safety and system operations, it contains data on several metrics related to project development and delivery and routine system maintenance. The dashboard contains performance indicators which graphically represent if performance benchmarks have been met. Figure 3.5 illustrates the portion of this dashboard that zeroes in on project development and delivery.

| Measure | Type | AY 2019 Target | AY 2019 Result | Performance Indicator | AY 2020 Target |
|---|---|---|---|---|---|
| **Project Development and Delivery** | | | | | |
| Percent of Design Projects Delivered On Time | Outcome | 79% | 85% |  | 81% |
| Percent of Construction Projects Completed on Budget | Outcome | 85% | 83.82% |  | 85% |
| Percent of Two-lane Highways 26 Feet or Wider in Paved Width | Outcome | 49.6% | 52.5% |  | 49.8% |
| Percent of Construction Projects Completed on Time | Outcome | 65% | 64.96% |  | 65% |
| Number of Construction Project Preliminary Engineering Plans Completed | Output | 680 | 849 |  | 570 |
| Dollar Volume of Construction Contracts Awarded in Fiscal Year (Millions) | Output | $2,602 | $2,963 |  | $2,709 |
| Number of Projects Awarded | Output | 768 | 825 |  | 685 |

**Figure 3.5** TxDOT Performance Results Summary Dashboard

### 3.2.3 Nevada

In 2007, the passage of Assembly Bill 595 obligated the Nevada DOT (NDOT) to create a performance management plan and adopt performance measures relevant to its operational requirements. Project selection for NDOT's Statewide Transportation Improvement Plan (STIP) is guided by performance measures. Projects included in the STIP are identified through a project tradeoff analysis. The agency anticipates that using performance data to prioritize projects will more meaningfully align the STIP process with strategic goals. While all of NDOT's major divisions are responsible for monitoring quarterly, annual, and long-term performance targets, its Performance Analysis section supplies information on value engineering data, analyses, and recommendations to support the department's mission and goals. Among its other responsibilities, the section coordinates work on performance measurement, reports on the highway preservation program, and performs cost-benefit analysis studies.

To fulfill its legislative mandate, NDOT tracks 15 performance measures across five categories (Table 3.6). Although the agency lacks an online performance dashboard, it issues an annual performance management report that include a performance dashboard.[13] Entries for individual performance measures summarize performance trends, specify goals, contain fine-grained performance data, evaluate the performance measure, and specify an annual goal. The evaluation for each performance measure addresses whether the annual target was met, identifies improvement strategies that were successful or unsuccessful, specifies improvement strategies planned for use during the upcoming fiscal year, looks at whether the performance metric effectively measures what it purports to and if a better measure should be considered, and discusses anticipated fiscal impacts for meeting the next year's target. The performance management report also contains project update sheets for major projects. These sheets include project information, including a description, schedule, cost ranges, benefits and risk, changes since last update, expenditures, and percentage of work complete.

[13] The most recent version of NDOT's annual report can be found at: https://www.dot.nv.gov/home/showdocument?id=17402

**Table 3.6** Nevada DOT Performance Measures

| **Employee** |
|---|
| • Reduce Workplace Accidents<br>• Injuries/Illnesses Per 100 Employees<br>• Injuries/Illnesses requiring Medical Attention Per 100 Employees<br>• Provide Employee Training<br>• Percentage Employees Trained According to Requirements<br>• Improve Employee Satisfaction<br>• Percentage Employees Satisfied with NDOT |
| **Project Delivery** |
| • Streamline Agreement Process<br>• Percentage Agreements Processed Within 30 Days<br>• Streamline Project Delivery — Bid Opening to Construction Completion<br>• Percent Projects Completed Within 10% of Original Programmed Budget<br>• Percent Projects Completed Within 10% of Original Assigned Working Days<br>• Percent Projects Completed with Cost Increase of Less than 3% Change Orders<br>• Streamline Project Delivery — Schedule and Estimate for Bid Advertisement<br>• Percentage of Scheduled Projects Advertised within the Reporting Year<br>• Percentage of Advertised & Awarded Projects Within Established Estimate Ranges<br>• Streamline Permitting Process<br>• Percentage Encroachment Permits Processed Within 45 Days |
| **Assets** |
| • Maintain State Highway Pavement<br>• Safe Roadways Maintained at *Fair or Better* Condition<br>• Maintain NDOT Fleet<br>• Percentage Mobile Equipment in Need of Replacement<br>• Percentage Fleet In Compliance with Condition Criteria<br>• Maintain NDOT Facilities<br>• Percentage of Facility Assessments, and Priority Facilities Work<br>• Maintain State Bridges<br>• Number of SD or FO Department-Owned Bridges replaced or Rehabilitated |
| **Safety** |
| • Emergency Management, Security, and Continuity of Operations<br>• Percentage of Emergency Management Plans Implemented<br>• Reduce Fatal and Serious Injury Crashes<br>• Number of Traffic Fatalities<br>• Number of Serious Traffic Injuries<br>• Number of Fatalities Per 100 MVMT<br>• Number of Serious Injuries Per 100 MVMT<br>• Number of Non-Motorized Fatalities & Serious Injuries |
| **NDOT Partners** |
| • Improve Customer and Public Outreach<br>• Reduce and Maintain Congestion Levels on the State Roadway System<br>• Percent Person-Miles Traveled on Nevada Interstate That Are Reliable<br>• Percent Person-Miles Traveled on Nevada non-Interstate NHS Routes That Are Reliable<br>• Annual Hours of Peak Hour Excessive Delay Per Capita (Urbanized Area)<br>• Percent of Non-Single Occupancy Vehicle Travel in Nevada Urbanized Areas<br>• Freight trip reliability index |

Of particular interest in Table 3.6 is NDOT Partners, which has mobility-related measures. Definitions of each of these measures is provided in Table 3.7 from NDOT's website. The dashboard for these measures is illustrated in Figure 3.6.

**Table 3.7** NDOT Congestion Definitions

| |
|---|
| **Percent of Person-Miles Traveled that are reliable on the Nevada Interstate System**: This performance measure is used to show the reliability that a driver might expect from a certain stretch of roadway on the interstate system during certain times of the day. It can also be defined as the consistency of travel over time. This measure helps to reliably track changes that might occur in a segment of roadway throughout applicable time periods of the day that would impact a driver's travel time. This is done by calculating the 80th percentile of travel time and dividing it by the 50th percentile of travel time. The 80th percentile number represents a travel time that is higher than the expected time, and the 50th percentile number represents the normal expected travel time of the roadway segment. According to US DOT guidelines, a trip that takes more than one and half times the normal time is not considered reliable. The number of roadway segments that are reliable are then compared to the total number of analyzed roadway segments to give the percentage of roads that are reliable for the state or selected region.<br><br>**Percent of Person-Miles Traveled that are reliable on Nevada Non-Interstate NHS Routes**: This performance measure is used to show the reliability that a driver might expect from a certain stretch of roadway on the non-interstate system during certain times of the day. It is calculated using the same methodology as the percent of person-miles traveled on the interstate system that are reliable, the only difference is the non-interstate roadway segments being analyzed.<br><br>**Annual Hours of Peak-Hour Excessive Delay (PHED) Per Capita in Nevada Urbanized Areas**: This performance measure is used to show the annual hours of peak excessive delay per capita. Based on MAP21 requirements, this metric is currently applicable to urbanized areas exceeding 1 million people, which at this time, only consists of the Las Vegas metropolitan area. However, on January 1, 2022, the population threshold will change to urbanized areas exceeding 200,000 people. Excessive delay means the extra amount of time spent in congested conditions defined by speed thresholds that are lower than a normal delay threshold. For the purposes of this rule, the speed threshold is 20 miles per hour (mph) or 60 percent of the posted speed limit for each segment, whichever is greater during 15-minute intervals. The total excessive delay metric is also weighted by vehicle volumes and occupancy. Peak traffic periods are defined as weekday mornings from 6 a.m. to 10 a.m. and either 3 p.m. to 7 p.m. or 4 p.m. to 8 p.m. for weekday afternoons providing flexibility to State DOTs and MPOs.<br><br>**Percent of Non-Single Occupancy Vehicle Travel in Nevada Urbanized Areas**: This performance measure reflects the amount of people traveling to work by other means of transportation such as walking, biking, public transportation, carpool, commuter rail, and even telecommuting. Like PHED requirements for urbanized areas, this metric is only applicable to the Las Vegas metropolitan area currently. There are several different ways to capture this performance measure, and in Las Vegas, the American Community Survey (ACS) commuting (journey to work) data from the U.S. Census Bureau is the method utilized.<br><br>**Truck travel time reliability index on the Nevada Interstate System**: This performance measure is used to assess the reliability of travel time for trucks on Nevada's interstate system. To determine the reliability of a segment, a Truck Travel Time Reliability (TTTR) measure is calculated as the ratio of the longer travel times (95th percentile) to a "normal" travel time (50th percentile). The TTTR's of interstate segments are then used to create the TTTR Index for the entire interstate system using a weighted aggregate calculation for the worst performing times of each segment. Furthermore, the threshold of the TTTR index should be less than 1.5. Anything above 1.5 would indicate that the segments were unreliable because US DOT guidelines say, a trip that takes more than one and half times the normal time is not considered reliable. |

Source: https://www.dot.nv.gov/home/showdocument?id=17402

| | | | | | | |
|---|---|---|---|---|---|---|
| Improve travel reliability and reduce delay on the State Roadway System (6) | Percent of person-miles traveled on Nevada interstate that are reliable | 86.8% or higher | 85.1% | | | |
| | Percent of person-miles traveled on Nevada non-interstate NHS that are reliable | 70% or higher | 86.3% | | | |
| | Annual hours of peak-hour excessive delay per capita (Urbanized Areas) | 12 hrs or less | 7.4 hrs | | | |
| | Percent of non-single occupancy vehicle travel in Nevada urbanized areas | 21.3% or higher | 21.4% | | | |
| | Freight trip reliability Index | 1.28 or less | 1.28 | | | |

**Figure 3.6** NDOT Travel Reliability Performance Measures Dashboard

Duncan et al. (2018) shed light on the performance management culture at NDOT — both its strengths and limitations. As part of their study, researchers interviewed a number of agency staff about their experiences with performance management. Responses clarified some of the challenges of integrating performance measures into agency practices. Although NDOT is dedicated to a performance management culture, respondents were divided on the influence of performance measures in agency decision making. Some felt that performance metrics do in fact guide project selection. Others commented that the link between performance measure reporting and funding decisions is tenuous, which makes it challenging for division leads to justify data collection and analysis. This is an especially salient point given that several interviewees observed that gathering performance data is a relatively simple task, but data analysis often proves more cumbersome and complex.

Another issue some executives have found daunting is relating NDOT's mission to some of the performance measures. This highlights the importance of aligning performance measures with responsibilities. Duncan et al. also wrote about a lack of clarity regarding who is responsible for overseeing efforts to address different metrics. Other staffers they spoke with said that the scope of some performance measures is too expansive for them to be integrated into everyday division practices (further complicating questions about responsibility). Another problematic issue is that each division's internal staff does not participate in setting goals and objectives. This has two consequences. First, it hampers efforts of personnel to fully understand how and why performance metrics are used. Second, it prevents staff from fully committing to the organizational changes required to nurture a performance management culture. Some respondents said that periodically analyzing performance measurement data and evaluating inconsistent results have culminated in fixes to underlying issues. At the same time, respondents also noted that in some cases the analysis in performance management reports is sometimes held over from previous reports

### 3.2.4 Idaho

A 2009 performance audit of the Idaho Transportation Department (ITD) found that the agency lacked unified performance measures informed by strategic goals. The audit's findings prompted the state's governor to sign an executive order which, among other things, mandated that the agency establish strategic performance measures, create an office that would be responsible for overseeing and evaluating the development and implementation of performance measures, and identify existing data and gaps which could inform strategic performance measures. Eventually, work set in motion by the executive order led to the creation of a web-based dashboard that lets users view current and historical data on each performance measure (Figure 3.7).[14] The dashboard reports on 10 measures. When users click on a performance gauge, a new page opens. Here, users see performance benchmarks along with explanations of why the metric is important, how it is measured, and what ITD uses the data for. This page also contains graphs which chart performance trends for the last 6-10 years. Metrics associated with project development and delivery include: 1) Percent of Highway Project Designs Completed on or Ahead of Time, 2) Final Construction Cost as a Percent of Contract Award, and 3) Construction Cost at Award as a Percent of Budget.

[14] https://apps.itd.idaho.gov/Apps/Dashboard/

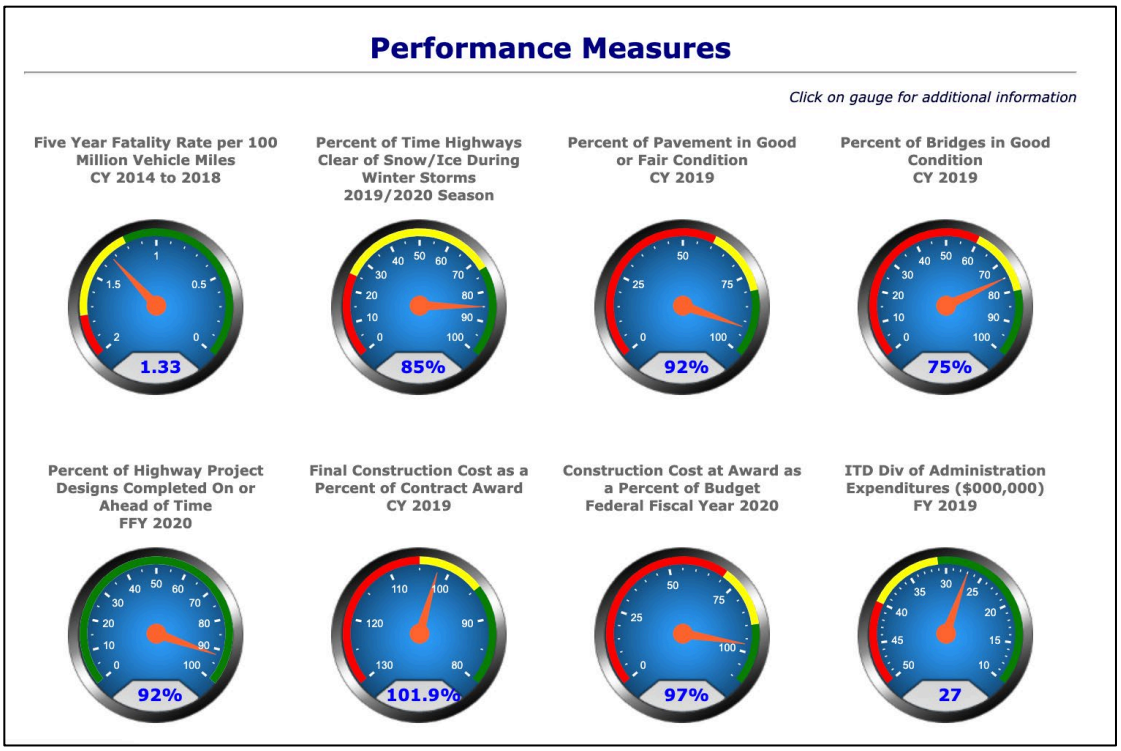



**Figure 3.7** Idaho Transportation Department Performance Dashboard

Over the past decade ITD has also expanded the area covered by its Winter Performance Measure System. This system lets the agency track the performance and determine the effectiveness of its winter maintenance operations. Data for the system come from Road Weather Information Systems (RWISs) scattered throughout the state. Each RWIS site contains atmospheric sensors and non-invasive pavement sensors that measure a road grip coefficient and road surface temperature. As part of this initiative, ITD has automated data collection for factors like salt usage, application rates, and liquid quantity usage. Data collected by RWIS sites are used to calculate three indices for each storm event: 1) a winter performance index (number of hours grip is less than 0.60 divided by the storm severity index); 2) a storm severity index (which accounts for maximum wind speed, water equivalent layer, and surface temperature); and 3) a mobility performance index (the percentage of time grip exceeds 0.60 when the surface layer is below freezing). The dashboard with the mobility performance index is shown in Figure 3.8. This approach to winter performance management aims to improve decision making and reduce the amount of time roads are in poor condition.

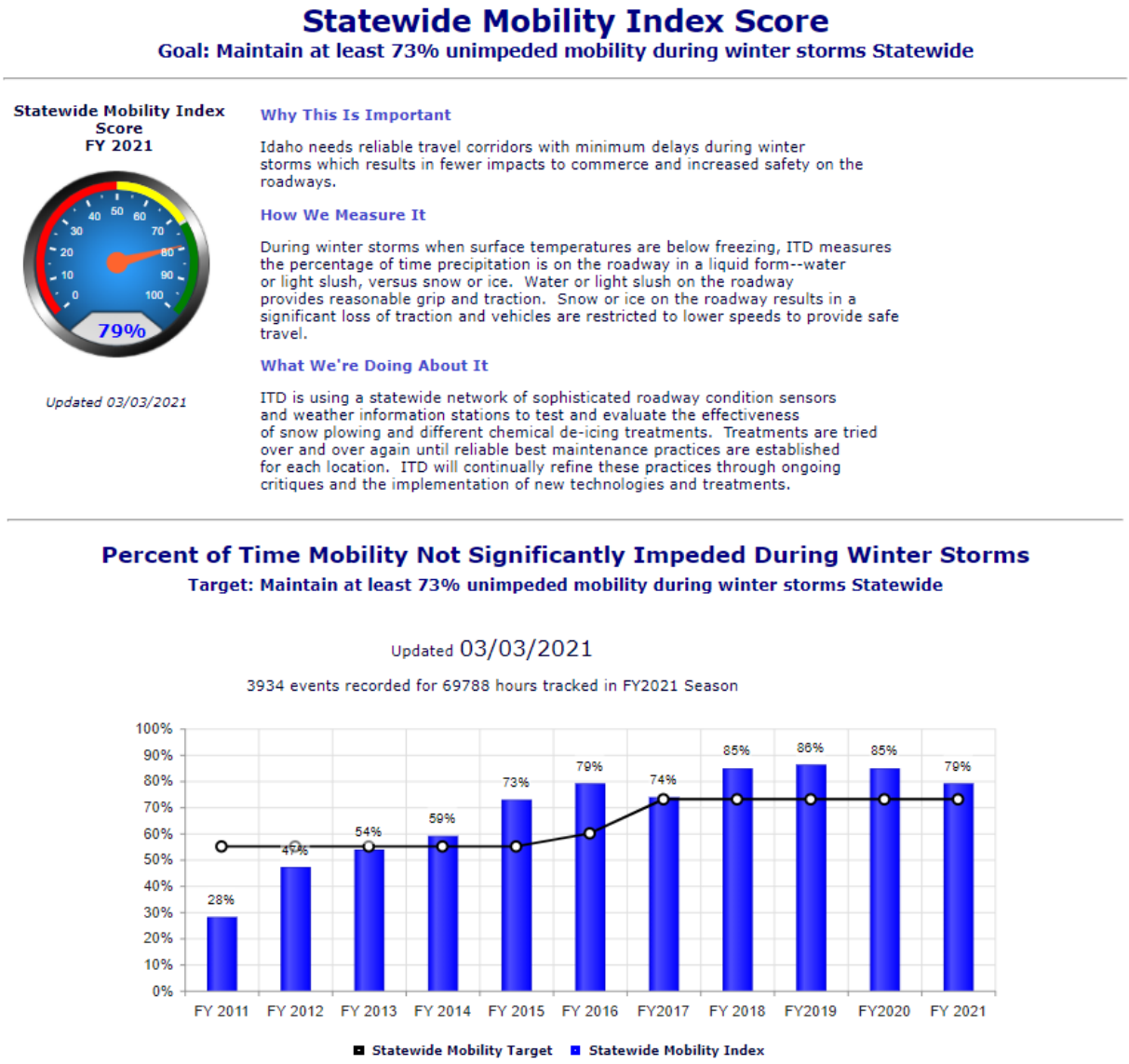



**Figure 3.8** ITD Statewide Mobility Index

### 3.2.5 Utah

The Utah DOT (UDOT) places special emphasis on connecting its mission, vision, and goals to the performance measures that is has adopted. UDOT's director has stressed the importance of routinely communicating with staff about the agency's mission, goals, and values and frequently interacts with staff, participates in orientations with new employees, and addresses the annual transportation conference to highlight their importance (Duncan et al. 2018). The agency also gets information on performance management to staff via its YouTube channel as well as a podcast series, *Beyond the Barrels*. All division directors and regional managers also meet with employees at all levels to discuss the agency's mission and values.

UDOT has adopted a performance-based asset management approach for its Tier 1 assets, which includes pavement, bridges, ATMS devices, and signal devices. While the agency submits required performance measures and goals to the federal government, it views state measures as providing the foundation upon which everyday decision making relies. Like many agencies, UDOT maintains an online dashboard that presents information on performance

measures.[15] This site leads with an overview of the agency's mission and operational characteristics, which implicitly tie the mission to performance measurement. Next, it provides data on strategic goals (zero fatalities, infrastructure preservation, and optimizing mobility). Separate dashboards are available for mobility (Figure 3.9), project development and delivery, federal performance measures, and freeway performance metrics. Table 3.8 lists performance measures included on the agency's main dashboard. Definitions of the mobility performance measures are in Table 3.9 The dashboard also hosts division-level tactical measures, but these are available to internal staff only. UDOT has a robust maintenance rating program as well, and maintenance stations participate in developing maintenance-related goals. According to Duncan et al. (2018), each month the agency evaluates performance metrics to identify strategies for mitigating deficiencies. Performance management is also used to support budgeting decisions and justify full-time equivalent staffing requests.

**Table 3.8** Utah DOT Dashboard Metrics

| |
|---|
| **Safety Performance Measures** |
| • Traffic Fatalities<br>• Traffic Serious Injuries<br>• Traffic Crashes<br>• Internal Fatalities<br>• Internal Injuries<br>• Internal Equipment Damage<br>• Historic Safety Index |
| **Mobility Performance Measures** |
| • Delay<br>• Reliability<br>• Mode Split<br>• Snow Removal<br>• Historic Mobility Index |
| **Infrastructure Performance Measures** |
| • ATMS<br>• Bridges<br>• Pavements<br>• Signals<br>• Historic Infrastructure Index |
| **Project Delivery Status** |
| • Number of: Past Due Projects, Projects to Advertise within 60 Days, Projects with Advertising Date > 60 Days Out, Other Projects, Total Projects |
| **Current Fiscal Year Advertising Performance** |
| • Percentage of Projects Advertised on Time<br>• Total Number of Advertised Projects<br>• Total Project Value of Advertised Projects |
| **Total Cost Estimates for Projects** |
| • Cost Estimate in Relation to Project Value<br>• Actual Advertised Date in Relation to Committed Advertised Date |
| **Advertising Status** |
| • Number of Projects Advertised on or Before Committed Advertising Date<br>• Number of Projects Advertised After the Committed Advertising Date |
| **Project Count and Construction Costs** |
| • Number of Contracts Under Construction<br>• Value of Contract Payments Made |

[15] http://www.udot.utah.gov/strategic-direction/

| |
|---|
| • Value of Outstanding Contract Payments |
| **Contracting** |
| • Monthly Contractor Payments<br>• Contract Award vs. Engineers' Estimate |

**Table 3.9** Utah DOT Mobility Definitions

| Mobility Performance Measures | Definition |
|---|---|
| Delay | Delay is the sum of additional travel time on major routes (Interstates, highways and arterials) in the state each month. Delay is measured as the difference between the actual travel time and free-flow travel time. |
| Reliability | Reliability is the percent of miles on major routes that were uncongested and performed consistently with historical speeds during the peak hour. |
| Mode Split | The Mode Split performance measure score is determined by dividing the actual percentage of transit trips by the target percentage transit trips and multiplying by 100. |
| Snow Removal | Noted as the percentages represent current winter efforts success in our ability to maintain roadways free of snow and ice. |
| Historic Mobility Index | Not defined |

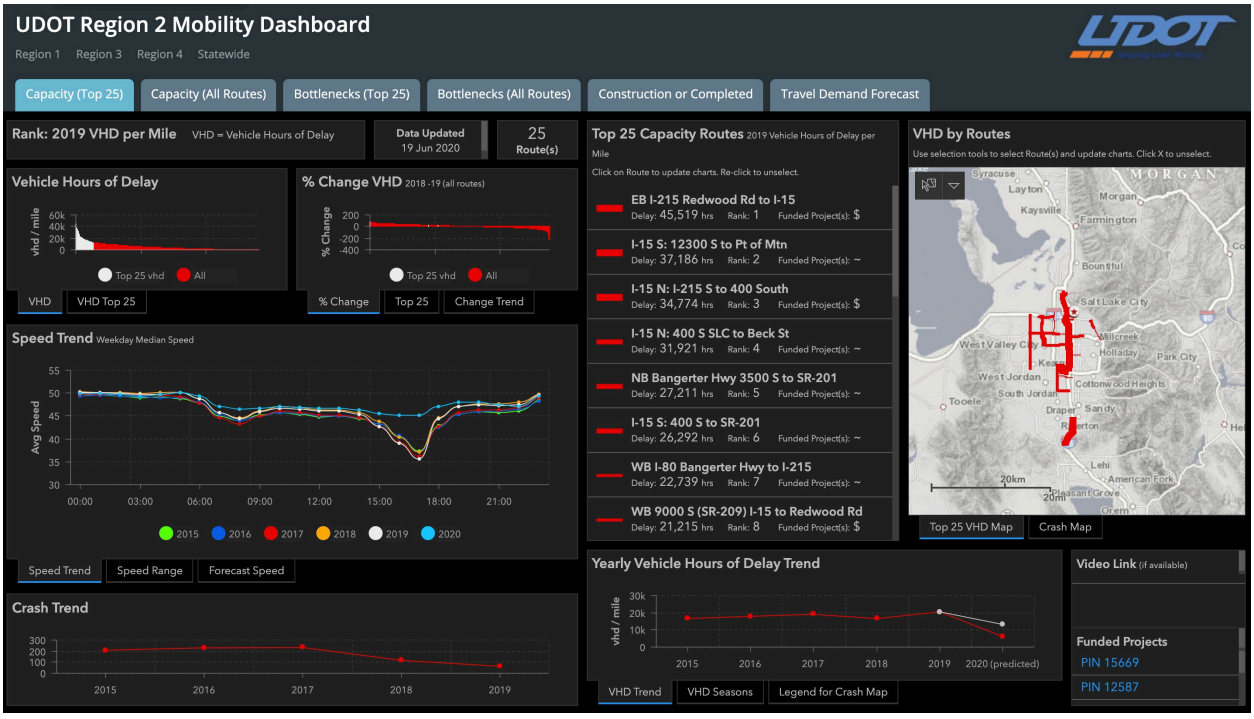



**Figure 3.9** Utah DOT Mobility Dashboard

Over the next 30 years rapid population growth is anticipated in Utah (particularly in the Salt Lake City metro area). In response, UDOT and several other transportation agencies funded the Wasatch Front Central Corridor Study, which has envisioned scenarios for how to accommodate increasing demands on multimodal transportation

systems. Scenarios varied in how they balance construction-based solutions and management-based solutions. What merits attention are the performance measures used to rank different scenarios (Figure 3.10), especially those that adopt a more holistic view of transportation systems (e.g., access to employment, job creation, transit usage).

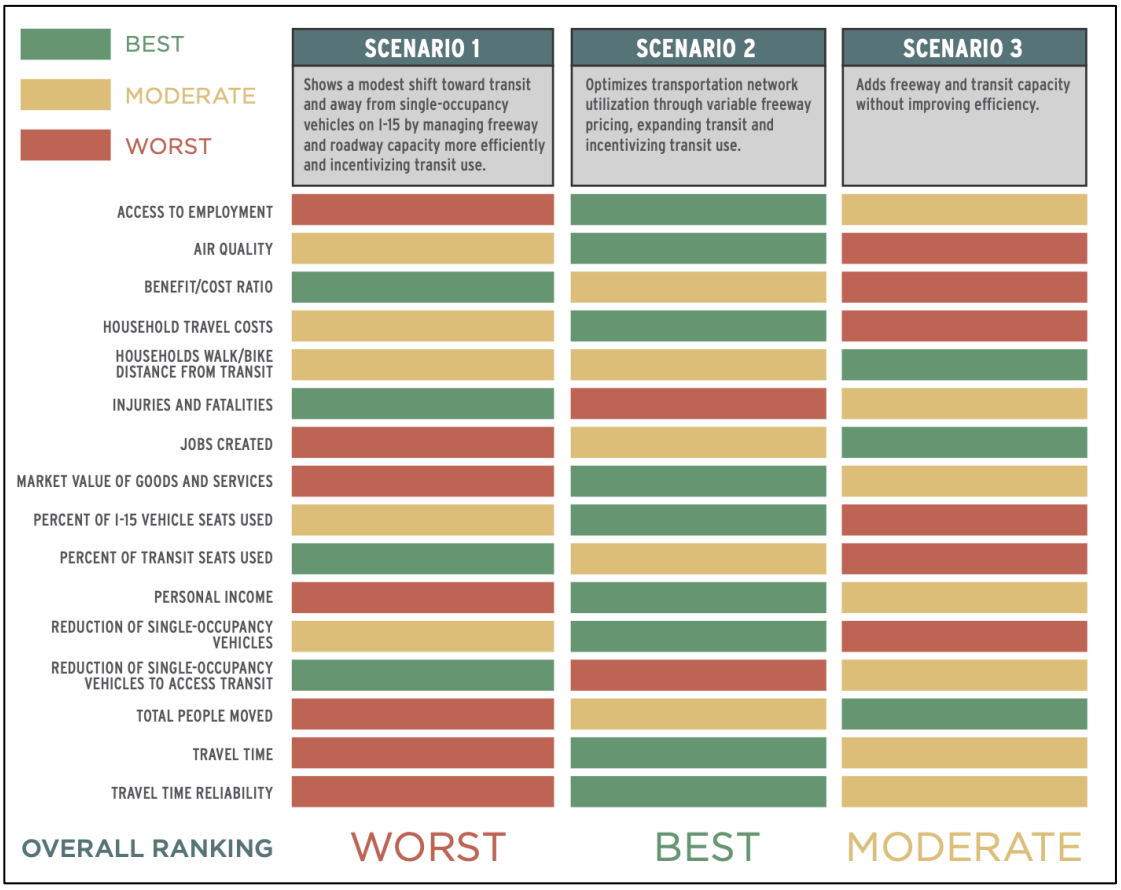



**Figure 3.10** Performance Measures Used in Wasatch Front Corridor Study

### 3.2.6 Minnesota

The Minnesota DOT's (MnDOT) performance management system covers major products, services, and priorities. Decisions about investments and operations are shaped by policies, performance data and performance forecasts. The agency has stressed the importance of performance management because it fosters accountability and transparency, guides informed decision making, ensures the agency complies with legislative mandates, strengthens internal management, helps refine programs and services, and can be used to establish benchmarks. MnDOT's Policy AD006 (Performance Measure and Target Adoption) provides directions on how new performance measures can be adopted as well as outdated metrics that have been retired. The introduction of new measures proceeds along one of the following two paths: 1) a planning processes that includes a formal public comment period, or 2) internal review and approval by a designated management group. Irrespective of which path is taken, a key consideration is whether a proposed measure aligns with MnDOT's vision, state and federal requirements, departmental priorities, and public expectations. A benefit of having this policy in place is that it establishes a uniform process for adopting, revising, and retiring performance measures and targets. And before introducing or modifying performance measures and targets, the agency carefully scrutinizes commitments, relative priorities, and tradeoffs. Table 3.10 lists performance measures currently tracked on MinnesotaGO's Performance Dashboard.[16]

[16] https://performance.minnesotago.org/

**Table 3.10** Minnesota DOT Performance Measures

| |
|---|
| **Roads** |
| • Interstate Reliability<br>• Minneapolis-St. Paul Area Freeway Congestion<br>• Truck Travel Time Reliability Index<br>• Average Incident Clearance Time<br>• Percentage Frequency of Meeting Bare Lane Targets<br>• Winter Severity Index<br>• Job Accessibility by Car |
| **Environment** |
| • Greenhouse Gas Emission<br>• MnDOT Environmental Initiatives (Percentage of Acres Planted with Native Seeds as Part of Large Projects, Percentage of Light Fixtures Using LED Luminaires)<br>• Road Salt Use<br>• Fuel Use |
| **Safety** |
| • Aviation Safety<br>• Emergency Radio System<br>• Roadway Fatalities<br>• Roadway Serious Injuries |
| **Transit** |
| • Community Transit Service<br>• Job Accessibility by Transit<br>• Twin Cities Metro Area Transit Ridership<br>• Greater Minnesota Transit Boardings |
| **Bicycle/Pedestrian** |
| • Percentage of State-Owned Sidewalk Miles Substantially Compliant with ADA Standards<br>• Percentage of State Highway Curb Ramps Compliant with ADA Requirements,<br>• Percentage of Eligible State Highway Intersections with Accessible Pedestrian Signals Installed<br>• Percentage of Survey Respondents Perceiving Safe Environments for Bicycling/Walking |
| **Freight/Rail** |
| • Annual Number of Rail Derailments |
| **Workforce** |
| • Percentage of Total Headcount for Women and Minorities in Highway Projects<br>• Hours for Women and Minorities (Entire Season)<br>• Participation in On-the-Job Training, Women and Minorities Working at MnDOT |
| **Bridges** |
| • Percentage of Bridge Inspections Completed on Time<br>• Percentage of Culvert Inspections Completed on Time<br>• Percentage of Culverts in Poor or Severe Condition<br>• NHS Bridge Deck Area Condition<br>• Non-NHS Bridge Deck Area Condition |
| **Customer** |
| • Percentage of Respondents Indicating Confidence in MnDOT to Build Roads and Bridges<br>• Percentage of Respondents Indicating Confidence in MnDOT to Maintain Roads and Bridges<br>• Percentage of Respondents that Believe MnDOT Considers Customer Concerns When Developing Transportation Plans<br>• Percentage of Respondents Indicating Confidence in MnDOT's Ability to Communicate Accurate Information to Residents About Transportation Plans and Projects |

| |
|---|
| • Percentage of Respondents Indicating Confidence in MnDOT's Ability to Provide Alternative Transportation Options For the Future<br>• Percentage of Respondents Agreeing that MnDOT Acts in a Fiscally Responsible Manner<br>• Percentage of Respondents Indicating Agreeing That MnDOT Can Be Relied Upon to Deliver Minnesota's Transportation System |

MinnesotaGO's landing page links to each topical area and performance measures. For each metric, users can view historical trends, which are typically represented with bar and line graphs; these are accompanied by a narrative explanation that reviews how the metric is calculated and efforts that have been made to improve asset condition. Small informational boxes at the bottom these pages highlight related measures, present information on actions that MnDOT uses to resolve problems, and links to external resources. Users can also click on a box labeled *Why is This Important*? that explains why MnDOT uses a specific performance measure. Information on measures related to responsviness and mobility are defined in Table 3.11.

**Table 3.11** Select Minnesota DOT Performance Measure Definitions

| **Roads** | **Definition** |
|---|---|
| Interstate Reliability | FHWA: https://ops.fhwa.dot.gov/publications/tt_reliability/brochure/ |
| Minneapolis-St. Paul Area Freeway Congestion | Traffic flowing at speeds less than 45 mph |
| Truck Travel Time Reliability Index | Ratio of total truck travel time needed to ensure on time arrival to the agency demined threshold travel time |
| Average Incident Clearance Time | Total time from report of an incident to the time the last vehicle clears the roadway; target of 35 minutes |
| Percentage Frequency of Meeting Bare Lane Targets | Based on traffic volumes, each state highway is assigned one of 5 time frames from 0-3 hours for high traffic roads to 9-36 for less travelled during winter events |
| Winter Severity Index | Includes Dew Point/relative humidity, wind speed gusts and direction, frost/black ice, precipitation type and duration amounts, air temperature, road temperature, cloud cover, blowing snow, and surface pressure. |
| Job Accessibility by Car | Jobs accessible within 30-minute drive in Twin Cities during morning peak period |
| **Customer** | **Definition** |
| • Percentage of Respondents Indicating Confidence in MnDOT to Build Roads and Bridges<br>• Percentage of Respondents Indicating Confidence in MnDOT to Maintain Roads and Bridges<br>• Percentage of Respondents that Believe MnDOT Considers Customer Concerns When Developing Transportation Plans<br>• Percentage of Respondents Indicating Confidence in MnDOT's Ability to Communicate Accurate Information to Residents About Transportation Plans and Projects<br>• Percentage of Respondents Indicating Confidence in MnDOT's Ability to Provide Alternative | Annual percent of survey respondents responding positively |

| | |
|---|---|
| Transportation Options For the Future<br>• Percentage of Respondents Agreeing that MnDOT Acts in a Fiscally Responsible Manner<br>• Percentage of Respondents Indicating Agreeing That MnDOT Can Be Relied Upon to Deliver Minnesota's Transportation System | |

The agency also publishes a transportation results scorecard each year that summarizes information found across the performance dashboard 's multiple pages (Figure 3.11). Performance measures are organized according to the strategic operating plan priority they fall under: Customer Trust, Workforce Excellence, and Operational Excellence. Individual entries describe performance measures, targets and results, presents a score based on results (i.e., good, needs improvement, or poor), visualizes multi-year trends, and offers a brief analysis.

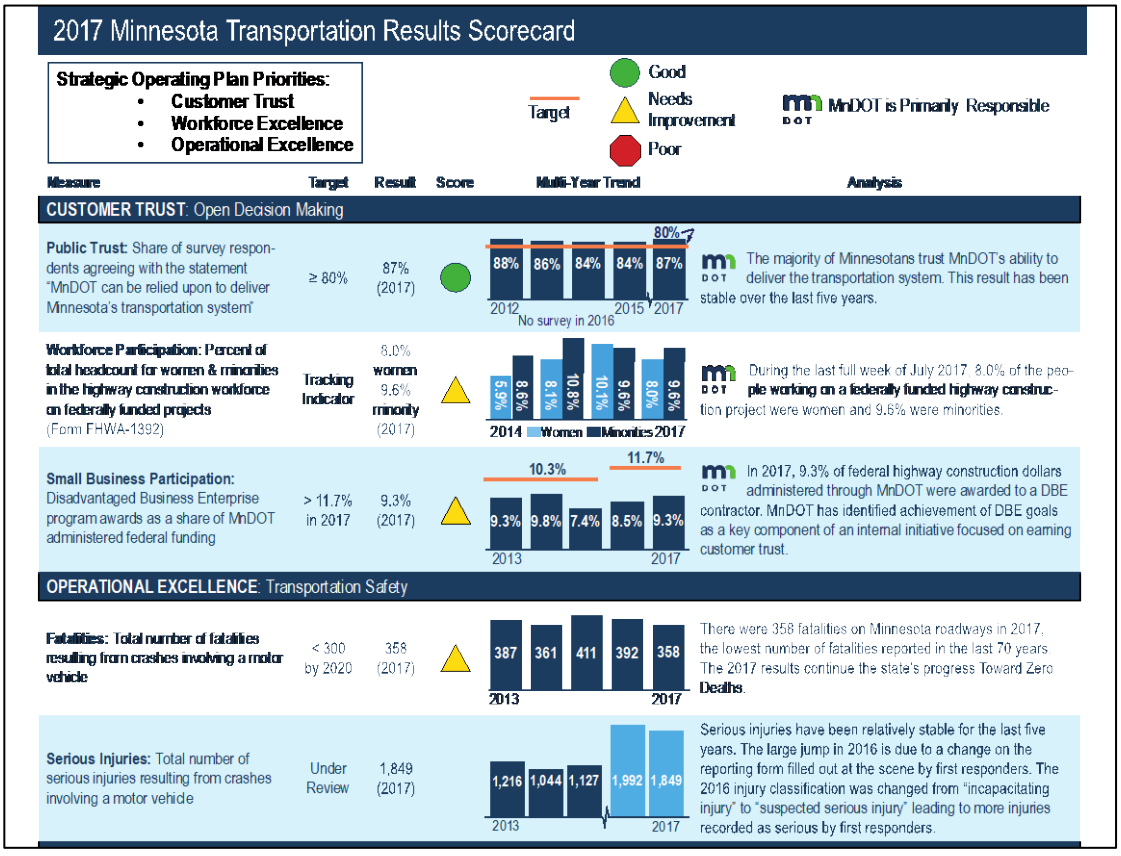



**Figure 3.11** Minnesota DOT Transportation Results Scorecard

### 3.2.7 South Carolina

The South Carolina DOT (SCDOT) measures performance in several areas and updates its performance dashboard before each monthly commission meeting. Performance management is used to track how well the agency is progressing toward its goals using outcome-based measures. Information derived through performance measurement and management is used to shape decisions about agency goals, targets, and investment levels. The agency has devised a strategic plan that will help it realize its goal of repairing and rebuilding the state's transportation network over the next 10 years and has created a Strategic Plan Performance Dashboard which lets

the public monitor progress toward its goals.[17] The strategic plan lists five goals. Each goal is accompanied by strategies to achieve that goal, objectives and performance targets, and performance measures used to track progress toward objectives (Figure 3.12). Some goals have multiple targets. For instance, a strategy under Goal 3 is increasing SCDOT's reliability at delivering projects on-time and on-budget. One measure adopted to track performance in this area is percentage of projects completed on schedule and within the allocated construction budget. Two separate targets were established for the July 2017 – June 2020 period: complete 80 percent or more of all projects within contract time, and complete 90 percent of all projects within budget. Performance measures for project management and delivery and maintenance are mostly found under Goals 3 and 4 (Goal 2 includes the resolution of maintenance work requests as a metric).

**Table 3.12** South Carolina DOT Strategic Goals Performance Measures

| **Goal 1: Improve Safety Programs and Outcomes in High-Risk Areas** |
|---|
| • Annual traffic fatalities<br>• Miles under contract in rural areas<br>• Rural miles completed in current fiscal year |
| **Goal 2: Maintain and Preserve Existing Transportation Infrastructure** |
| • Annual average of percentage of routine maintenance work requests resolved within 30 days<br>• Percentage of pavements in good condition, number of load-restricted bridges<br>• Maintenance assessment program scores for individual asset categories<br>• Number of SCDOT title public transit vehicles past their useful life<br>• Number of certified DBEs and SBEs that receive technical training, business development management assistance through SCDOT |
| **Goal 3: Improve SCDOT Program Delivery to Increase the Efficiency and Reliability of the Road and Bridge Network** |
| • On-time delivery of critical interstate-to-interstate interchanges improvement projects<br>• Percent of phrases authorized on schedule for interstate widening and bridge replacement projects<br>• Percent of projects completed on-time and on-budget<br>• Development and initiation of a watershed mitigation strategy |
| **Goal 4: Provide a Safe and Productive Work Environment for SCDOT Employees** |
| • Number of *Let 'Em Work, Let 'Em Live* Messages Transmitted to the Public<br>• Number of Reportable Workplace Injuries and SCDOT<br>• Number of SCDOT Team Members that Have Received Updated Customer Service Training<br>• Number of Days to Decision for Commercial Development Permits<br>• Development and Implementation of Succession Management Planning |
| **Goal 5: Earn Public Trust Through Transparency, Improved Communications, and Audit Compliance** |
| • Revamping the website to focus on core areas<br>• Number of speaking engagements<br>• Statewide, district, and county reports published monthly on webpage<br>• Publish a simpler description of how projects are prioritized<br>• Continuous management of a repository with regular updates, including verified management action plans |

Although the layout of SCDOT's performance dashboard is less dynamic and simpler than dashboards maintained by some other agencies, it has intuitive navigation and presents information in an easily understood way (Figure 3.12). Strategies and their associated objectives and performance measures are listed in a box and then followed by graphs that chart performance.

[17] https://www.scdot.org/performance/performance-dashboard.aspx

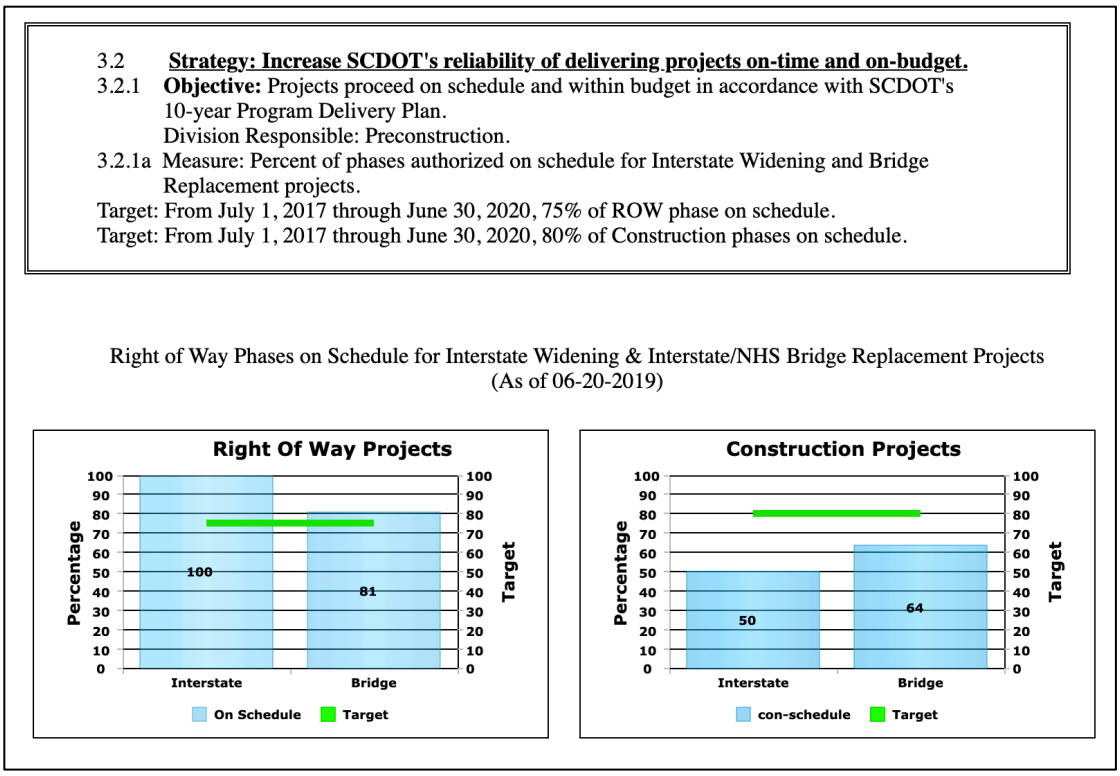



**Figure 3.12** Layout of South Carolina DOT Performance Dashboard

### 3.2.8 Maryland

The Maryland DOT (MDOT) released a *MAP-21 / FAST Act Performance Management Road Map* that describes its reporting obligations under the FHWA's Transportation Performance Management requirements. It includes information about federally mandated performance measures, targets, and methods for calculating metrics. The agency also maintains an Esri Story Map that summarizes its approach to obligatory performance management.[18] This site includes an interactive webmap which displays pavement condition data for the NHS. Users have the option to download these data as well as bridge condition data.

MDOT also has introduced the Excellerator Performance Management System. The agency regards it as a customer-oriented system that helps communicate to the public how and why resources are being allocated as they are, offers evidence of its commitment to fiscal responsibility, and influences everyday decisions about agency operations. An Excellerator report is published every quarter; it serves as a report card for Maryland's residents by documenting how well the agency is providing transportation services. MDOT views the program as a living, evolving performance process continually undergoing evaluation, analysis, and action. Excellerator prioritizes 10 Tangible Results (individual areas of performance management). Within its base performance management program driven by MAP-21 and FAST Act requirements, MDOT measures travel time reliability as percentage of person-miles travelled on the Interstate and Non-Interstate NHS systems that are reliable and for trucks uses a truck travel time reliability index. Travel time reliability is based on MDOT's forecasted reliability performance compared to travel demand trends and current and planned investments, while the truck travel time reliability index is based on forecasted freight reliability performance relative to a 2017 baseline.

Current and archived reports can be accessed via the agency's website.[19] Some reports have a more traditional format, whereas reports issued over the past year consist of slides that illustrate performance trends. For reports

[18] https://www.arcgis.com/apps/MapJournal/index.html?appid=3542e7706b5a4bbabec38d927dace114
[19] Archived reports may be downloaded at the Excellerator home page: https://www.mdot.maryland.gov/tso/pages/Index.aspx?PageId=170

that assume a more traditional form, write-ups for each performance measure identify the Tangible Result Driver and Performance Measure Driver, describe the measure and frequency of reporting, specify data collection procedures, list the benchmark, and provide a narrative which relates information on recent and historical performance.

Table 3.13 lists a selection of performance measures tracked as part of Excellerator, including several related to project delivery and management (e.g., percentage of projects advertised as scheduled, percentage of projects bid on schedule — most are found under Tangible Result #4) as well as responsiveness (Tangible Result #1,5,6). Definitions of the measures in Tangible Results 1, 5, and 6 are available in Table 3.14. Some performance measures have several metrics associated with them.

**Table 3.13** Selected Maryland DOT Performance Measures

| **Tangible Result #1 — Provide Exceptional Customer Service** |
|---|
| • Overall Customer Satisfaction<br>• Responsiveness to MDOT Customer Correspondence<br>• Customer Satisfaction with Receiving Goods and Services<br>• Customer Satisfaction with Interactions with MDOT Representatives |
| **Tangible Result #2 — Use Resources Wisely** |
| • Percent of Capital Dollars Spent as Programmed<br>• Percent of Procurements on Time and on Budget<br>• Percent and Value of Unanticipated Contract Modifications<br>• Relationship Between Procurement Competition and Cost<br>• Employee Turnover Rate<br>• Managing Capital Assets<br>• Number of Legislative Audit Findings and Repeat Audit Findings<br>• Average Days to In-Service |
| **Tangible Result #3 — Provide a Safe and Secure Transportation Infrastructure** |
| • Number of Crimes Against Persons and Property Committed at MDOT Facilities<br>• Number of Traffic-Related Fatalities on All Roads<br>• Number of Traffic-Related Serious Injuries on All Roads<br>• Travelers Assisted by MDOT<br>• Number of Employees Trained Under National Incident Management System<br>• Number of Employee Lost Workdays Due to Injuries<br>• Number of Customer Incidents at MDOT Facilities<br>• Time of Notification of Unacceptable Guardrail to Return to Service |
| **Tangible Result #4 — Deliver Transportation Solutions and Services of Great Value** |
| • Percent of Estimated Project Budget as Compared to Final Project Award<br>• Percent of Change for Finalized Contracts<br>• Average Cost of Common Solutions and Services (i.e., public transit)<br>• Percent of Projects (Valued at More than $1 Million) Advertised Within 30 Days of the Original Established Financial Advertisement Date<br>• Percent of Projects (Valued at More than $1 Million) with a Bid Opening Date on Target with the Bid Opening Date at the Time of Actual Advertisement Date<br>• Percent of Projects Completed by Original Contract Date |
| **Tangible Result #5 — Provide an Efficient, Well-Connected Transportation Experience** |
| • Reliability of the Transportation Experience<br>• Customer Satisfaction with Helpfulness and Accuracy of Real-Time Systems Provided |
| **Tangible Result #6 — Communicate Effectively with Our Customers** |
| • Social Reach (Total MDOT Social Media Followers, Total MDOT Social Media Reach, Total MDOT Social Media Engagements)<br>• Number of News Stories Generated from Major Releases |

| |
|---|
| • Earned Media Value of Print and Broadcast Coverage Generated by News Releases<br>• News Tone of Coverage Generated by MDOT News Releases<br>• Proactive Media |
| **Tangible Result #7 — Be Fair and Reasonable to Our Partners** |
| • Percent of MBE Participation Achieved<br>• Percent of Payments Awarded to Small Business Reserve (SBR) Contracts<br>• Percent of Veteran-Owned Small Business Enterprise Participation<br>• Invoices Properly Paid to Our Partners in Compliance with State Requirements<br>• MDOT Procurement Protests Filed and Upheld by the Board of Contract Appeals |
| **Tangible Result #8 — Be a Good Neighbor** |
| • Number of Traffic Violations While Driving a State Vehicle<br>• Charity Campaign Participation |
| **Tangible Result #9 — Be a Good Steward of Our Environment** |
| • Total MDOT Utility Generated Electricity Use & Cost<br>• Total MDOT Renewable Energy Generation<br>• Electric Vehicles Registered in Maryland<br>• Electric Vehicle Charging Outlets |
| **Tangible Result #10 — Facilitate Economic Opportunity in Maryland** |
| • Economic Return from Transportation Investment<br>• Estimated Number of Jobs Created by TBU Capital/Construction Programs<br>• Total User Cost Savings<br>• Percent of Roadway Access Permits Issued within 21 Days or Less<br>• Value of Land Sold |

**Table 3.14** Select Maryland Performance Measure Definitions

| Tangible Result #1 — Provide Exceptional Customer Service | Definition |
|---|---|
| Overall Customer Satisfaction | • Percent of overall customer satisfaction |
| Responsiveness to MDOT Customer Correspondence | • Average number of days in system<br>• Percentage of customers responded to within 24 hours |
| Customer Satisfaction with Receiving Goods and Services | • Percent of calls abandoned at call centers<br>• Average call wait times<br>• Level of satisfaction with resolving call inquiries |
| Customer Satisfaction with Interactions with MDOT Representatives | • Percent of customers who felt MDOT website met their needs<br>• Percent of customers who felt it was easy to find information |
| **Tangible Result #5 — Provide an Efficient, Well-Connected Transportation Experience** | **Definition** |
| Reliability of the Transportation Experience | • Percent of toll transactions by payment channel<br>• Average wait time at MDOT branches<br>• On time performance of transit<br>• Planning time index for highway travel |
| Customer Satisfaction with Helpfulness and Accuracy of Real-Time Systems Provided | • Monthly average of good performance prediction<br>• Time to restore operations after disruption, weather events |

| Tangible Result #6 — Communicate Effectively with Our Customers | Definition |
|---|---|
| Social Reach (Total MDOT Social Media Followers, Total MDOT Social Media Reach, Total MDOT Social Media Engagements) | • Social Reach<br>• Social Engagement |
| Number of News Stories Generated from Major Releases | • Self-explanatory |
| Earned Media Value of Print and Broadcast Coverage Generated by News Releases | • Public relations |
| News Tone of Coverage Generated by MDOT News Releases | • Evaluate tone- public relations |
| Proactive Media | • News customers can use |

The presentation of data in Excellerator reports is clean and straightforward, typically taking on the form of uncluttered bar graphs and line charts (Figure 5.13). Older reports contain greater detail on each performance measure, including the staff member responsible for measures, the purpose of each measure, frequency of reporting, data collection methods, national benchmarks, and explanations that discuss what is driving changes in performance levels. They also describe process improvement actions that have been introduced to improve results. MDOT lacks an online dashboard that presents all data collected as part of the Excellerator program, although at one point in time MDOT appears to have maintained an ArcGIS Online application for reporting purposes; however, it has not been updated in nearly two years. The agency has also published a couple YouTube videos which discuss aspects of Excellerator.

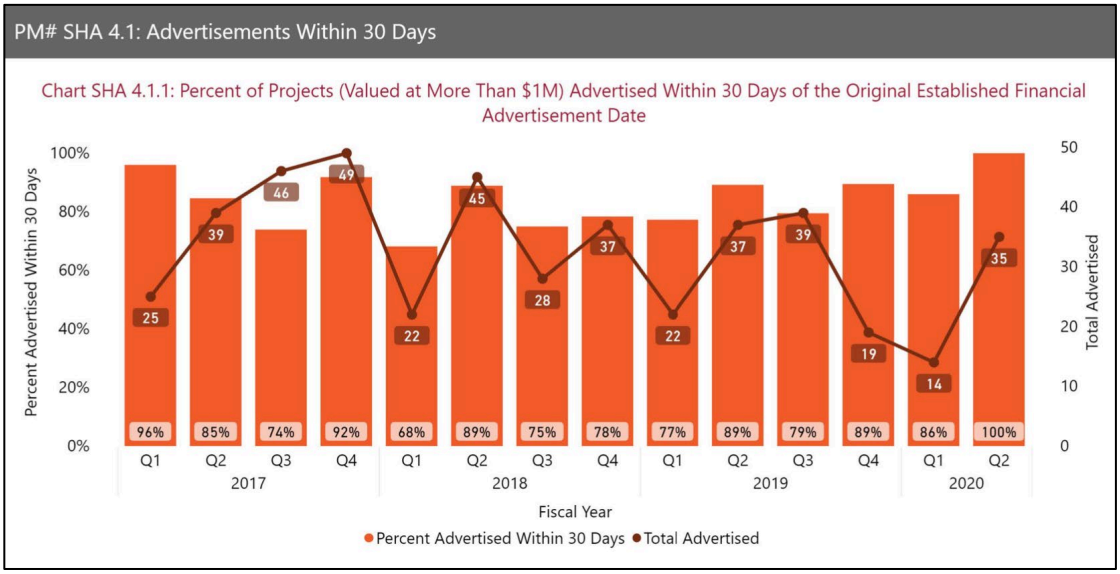



**Figure 3.13** Presentation of Data in Maryland DOT Excellerator Report

### 3.2.9 Missouri

The Missouri DOT (MoDOT) publishes a quarterly report called *Tracker: Measures of Departmental Performance* (hereafter, *Tracker*) that compiles data on whether the agency is successfully delivering services and products to its customers. The Tracker program measures outcomes which must be fulfilled if MoDOT is to successfully fulfill its mission. It is intended to bolster accountability and ensure customers have access to the information needed to determine if the agency is making progress toward its goal. All data are presented and summarized in reports which can be downloaded from MoDOT's website.[20] The agency does not have an interactive online dashboard.

[20] https://www.modot.org/tracker-measures-departmental-performance

*Tracker* opens with a national performance report that provides rankings for 10 key metrics: road conditions, customer satisfaction, project management, congestion, administrative costs, infrastructure for business, number of fatalities, bridge conditions, revenue, and employee turnover. It then delves into performance areas, each of which is evaluated using an array of performance measures. Performance areas include:

- Keep Customers and Ourselves Safe
- Keep Roads and Bridges in Good Condition
- Provide Outstanding Customer Service
- Delivery Transportation Solutions of Great Value
- Operate a Reliable and Convenient Transportation System
- Use Resources Widely
- Advance Economic Development

Responsibility for each performance area is assigned to a Result Driver. Similarly, for each performance measure a Measurement Driver is tasked with oversight responsibilities.

Write-ups for each performance measure identify the Result Driver and Measurement Driver, describe the purpose of the measure, and summarize data collection procedures. Narratives provide further background information on what the performance measure is trying to represent, highlight noteworthy statistics for the current fiscal year, and offer context by showing where current performance fits within a longer historical trajectory. Simple bar charts and line graphs are used to visualize results. Table 3.15 lists a subset of performance measures used by MoDOT — the table highlights metrics related to project development and delivery and agency operations. While this elides a number of measures, those which are omitted mostly focus on safety, infrastructure condition, and customer service.

**Table 3.15** Missouri DOT Selected Performance Measures

| **Keep Customers and Ourselves Safe** |
|---|
| • Number and Rate of Fatalities and Serious Injuries<br>• Number of Vulnerable Roadway User Fatalities and Serious Injuries<br>• Number of Fatalities and Serious Injuries resulting from the Most Frequent Crash Causes<br>• Number of Fatalities and Serious Injuries in Work Zones<br>• Percent of Seat Belt/Passenger Vehicle Restraint Use<br>• Number and Rate of Fatalities and Serious injuries Involving Commercial Motor Vehicles<br>• Total and Rate of MoDOT Recordable Incidents<br>• General Liability Claims and Costs |
| **Keep Roads and Bridges in Good Condition** |
| • Percent of Highways in Good Condition<br>• Condition of State Bridges<br>• Percent of Structurally Deficient Deck Area on National Highway System |
| **Provide Outstanding Customer Service** |
| • Percent of Overall Customer Satisfaction<br>• Percent of Customers Who View MoDOT as Missouri's Transportation Expert<br>• Percent of Customers Who Trust MoDOT to Keep Its Commitments to the Public<br>• Percent of Customers Who Feel MoDOT Provides Timely, Accurate and Understandable Information<br>• Percent of Customers Satisfied with MoDOT's Customer Service<br>• Customer Communication Engagement |
| **Deliver Transportation Solutions of Great Value** |
| • Percent of Programmed Project Cost as Compared to Final Project Cost<br>• Percent of Projects Completed On Time<br>• Percent of Change for Finalized Contracts<br>• Innovative Contracting Methods |

| |
|---|
| • Value Engineering<br>• Percent of Customers Who Believe Completed Projects Are the Right Transportation Solutions |
| **Operate a Reliable and Convenient Transportation System** |
| • Travel Times and Reliability on Major Routes<br>• Cost and Impact of Traffic Congestion<br>• Average Time to Clear Traffic incident<br>• Unplanned Incident Impacts on Major Interstate Routes<br>• Work Zone Delays to the Traveling Public<br>• Time to Meet Winter Storm Event Performance Objectives<br>• Bike/Pedestrian and ADA Transition Plan Improvements |
| **Use Resources Wisely** |
| • Number of Full-Time Equivalencies Expended<br>• Rate of Employee Turnover<br>• Level of Job Satisfaction<br>• State and Federal Revenue Budgets<br>• Number of Dollars Generated Through Cost-Sharing and Partnering Agreements for Transportation<br>• Percent of Local Program Funds Committed to Projects<br>• Fleet Age and Fuel Efficiency<br>• Number of Tons of Recycled Material<br>• Number of Environmental Warnings and Violations<br>• MoDOT State Ranking in Cybersecurity Incidents Per Employee<br>• Local Entity Cas Leveraged for Cost Share Program |
| **Advance Economic Development** |
| • Economic Return from Transportation Investment<br>• Freight Tonnage by mode<br>• Truck Travel Time Reliability Index<br>• Percent of Minorities and Women Employed<br>• Percent of Disadvantaged Business Enterprise Participation on Construction and Engineering Projects<br>• Expenditures Made to Certified Minority, Women, and Disadvantaged Business Enterprises |

A few performance measures that fall under *Deliver Transportation Solutions of Great Value* warrant clarification. *Percentage of Change for Finalized Contracts* quantifies as a percentage the difference between total construction payouts and the original contract award amounts. MoDOT regards this as a proxy for how many changes are made on projects following an award. *Innovative Contracting* monitors the use of A+B contracts, alternative technical concept contracts, and design-build contracts, both in terms of number of projects awarded and their value. Lastly, the *Value Engineering* metric tracks the use of value engineering during design and construction on traditional MoDOT projects, including value analysis during design, construction value engineering proposals, and integrating best practices into standards and polices. Metrics most closely related to responsiveness and mobility are further defined in Table 3.16

**Table 3.16** Missouri DOT Select Performance Measure Definitions

| Provide Outstanding Customer Service | Definition |
|---|---|
| Percent of Overall Customer Satisfaction | Data is collected through a biennial, in odd-numbered years, telephone survey of approximately 3,500 randomly selected Missourians. |
| Percent of Customers Who View MoDOT as Missouri's Transportation Expert | |
| Percent of Customers Who Trust MoDOT to Keep Its Commitments to the Public | |
| Percent of Customers Who Feel MoDOT Provides Timely, Accurate and Understandable Information | |
| Percent of Customers Satisfied with MoDOT's Customer Service | |

| | |
|---|---|
| Customer Communication Engagement | Google Analytics. Website traffic and YouTube information are cumulative totals based on visits. Facebook and Twitter information is based on account followers. |
| **Operate a Reliable and Convenient Transportation System** | **Definition** |
| Travel Times and Reliability on Major Routes | Travel time data is collected continuously via wireless technology. To assess mobility, MoDOT compares travel times during rush hour to free-flow conditions where vehicles can travel at the posted speed limit. This measure also assesses reliability, an indicator of how variable those travel times are on a daily basis.<br><br>The targets for average travel time are updated quarterly. The targets are established by projecting a 10% improvement over the average of the same quarter over the previous two years. The minimum value for the target time is 10 minutes. This corresponds to the time it takes to travel 10 miles at the posted speed limit of 60 miles per hour. |
| Cost and Impact of Traffic Congestion | A reporting tool available in the Regional Integrated Transportation Information System looks at user delay costs. This data, in combination with industry standard costs for passenger cars and trucks, reflects the overall costs of congestion. RITIS also includes historic data so trend lines can be tracked and evaluated. The unit cost per passenger car is $18.12 per hour and is obtained from the US Bureau of Labor Statistics. The unit cost per truck is $65.11 obtained from the American Transportation Research Institute, which specializes in tracking freight mobility and provides the best source of data related to freight costs. For previous reporting, the department used data provided by the TTI, which annually produces the Urban Mobility Report. The target for this measure is updated annually in April and is established by projecting a 10% improvement over a four-year average. |
| Average Time to Clear Traffic incident | Advanced transportation management systems are used by the St. Louis, Kansas City and Springfield traffic management centers to record incident start time and the time when all lanes are declared cleared. Traffic incidents can be divided into three general classes of duration set forth by the Manual on Uniform Traffic Control Devices that include minor, intermediate and major incidents. Each class has unique traffic control characteristics and needs. |

| | |
|---|---|
| | This target is established by projecting a 10% improvement over a five-year average. |
| Unplanned Incident Impacts on Major Interstate Routes | The limits of the interstates analyzed are as follows:<br>I-44: Oklahoma State Line to Route 100 in Gray Summit<br>I-70: Route 7 in Blue Springs to Route Z in Wentzville<br><br>Observed crashes are pulled from MoDOT's Transportation Management System and represent all reported crashes which occurred between the limits on each interstate. The miles used to determine the crash per mile are also pulled from MoDOT's Transportation Management System. Expected crash per year per mile numbers were calculated using the ISATE spreadsheets developed with the American Association State Highway Transportation Officials Highway Safety Manual. |
| Work Zone Delays to the Traveling Public | Work zone impacts are identified using automated data collection and visual observations. An impact is defined as the additional time a work zone adds to normal travel. Impacts resulting in a delay of at least 10 minutes are included in this report. The targeted hours of work zone congestion are based on previous years' data and an acceptable tolerance of 30 total minutes for work zone congestion statewide. The target for this measure is updated quarterly. |
| Time to Meet Winter Storm Event Performance Objectives | For major highways and regionally significant routes, the objective is to restore them to a mostly clear condition as soon as possible after the storm has ended. MoDOT calls these “continuous operations” routes. State routes with lower traffic volumes should be opened to two-way traffic and treated with salt or abrasives at critical areas such as intersections, hills and curves. These are called “non-continuous operations” routes. After each winter event, maintenance personnel submit reports indicating how much time it took to meet the objectives for both route classifications. For significant events, the Regional Integrated Transportation Information System is used to determine traveler delays and the associated costs in order to determine the magnitude of the impacts of these significant winter events. |

Source: https://www.modot.org/tracker-measures-departmental-performance

### 3.2.10 Virginia

The Virginia DOT (VDOT) maintains a dashboard which serves as a centralized reporting platform for performance measures across the agency. Currently, the agency is transitioning from Dashboard 3.0 to Dashboard 4.0.[21] Dashboard 3.0 contains information on Transportation Performance, Safety, Condition, Finances, VDOT Management, Citizen Surveys, and Projects. Only the Projects dashboard has been converted to the Version 4.0; therefore, that is our initial focus (Figure 3.14). Dashboard 4.0 provides a streamlined, more user-friendly interface with greater data analysis than Version 3.0. The agency plans to roll out Version 4.0 for one area at a time.

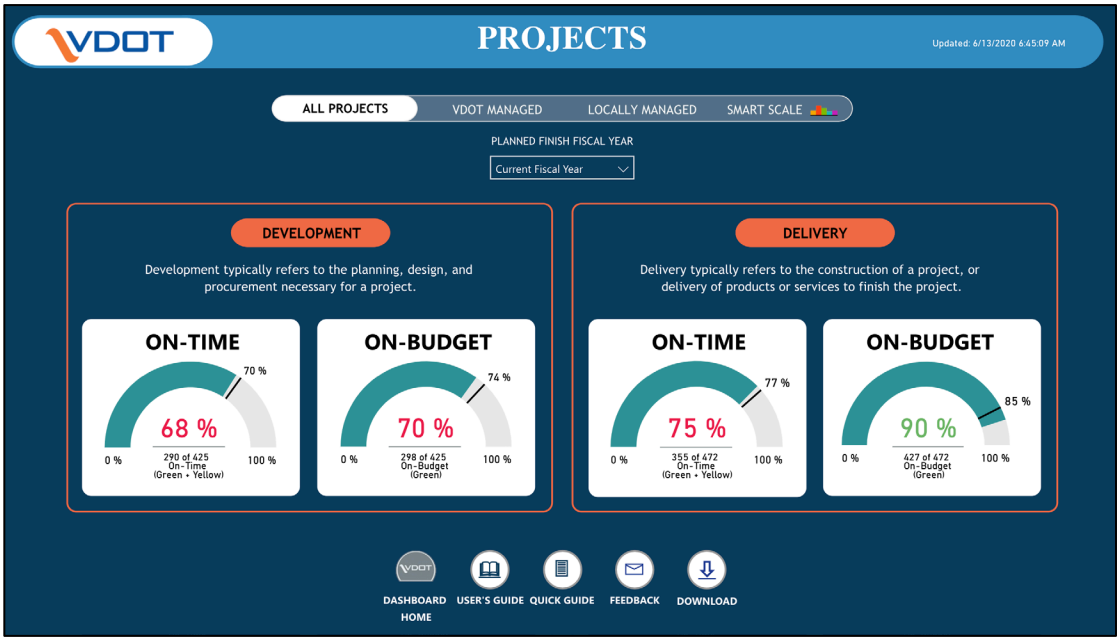



**Figure 3.14** Virginia DOT Projects Dashboard (v. 4.0)

Users opening up the Projects Dashboard encounter four dials. Each dial records information about performance measures. There are four — two for Project Development (On-Time and On-Budget) and two for Project Delivery (On-Time and On-Budget). The dials indicate what proportion of projects currently meet criteria for each measure. Table 3.17 describes each of these performance measures and specifies VDOT's target. For example, Project Delivery On-Time records whether a project finishes on or before the original completion date. The agency wants at least 77 percent of its projects to meet this criterion.

**Table 3.17** Virginia DOT Project Development and Delivery Performance Metrics

| Metric | Description | Agency Target |
|---|---|---|
| Project Development On-Time | • Measures performance of completing project activities from project approval until delivery phase begins and the project is awarded | 70% |
| Project Development On-Budget | • Measures whether projects have estimates within the approved budget | 74% |
| Project Delivery On-Time | • Measures if projects finish on or before the original completion date | 77% |

[21] The full dashboard can be found at: http://dashboard.virginiadot.org/. Users need to click through to the Projects dashboard to view the Version 4.0 layout.

| | | |
|---|---|---|
| Project Delivery On-Budget | • Compares original contract award amount to the current contract amount and cost of work done to date | 85% |

Users can further explore performance measures by clicking on the options for Development and Delivery. This opens up a new page with more fine-grained details (Figure 3.15). VDOT assigns a status to a project for project development activities and project delivery milestones as well as for budget phases. Current status is represented using one of three colors: green, red, or yellow. For Project Development and Delivery On-Time Performance, green indicates an activity or milestone is ahead of schedule or was completed on time, yellow means the planned finish date for an activity or milestone is nearing, and a red denotes that a milestone or activity is late and that some kind of intervention is needed to get the project back on schedule. With respect to Project Development and Delivery Budget Performance, the colors have similar meanings — green signals that estimated or actual costs are on or under budget, yellow means an estimated or actual cost exceeds the budget but not contingencies, and red indicates the estimated or actual cost is over budget and greater than contingencies. The metrics for on-time performance are used to encourage the early start and early finish of project development activities and project delivery milestones. Although Table 3.17 notes VDOT's goal for on-budget project delivery, the measure is slightly more nuanced than represented there. The agency's goal is for 85 percent of projects to not exceed 10 percent of the original construction contract award amount or not exceed 25 percent of the original paving work contact award amount. Figure 3.15 illustrates the Project Delivery Overview. The dashboard is fully interactive. For example, in the upper-left panel (On-Time Performance), users can click on a status symbol (e.g., green), which then lists in the bottom panel contract information for projects that are on schedule or ahead of schedule. The middle panel gives users the option to apply a number of filters so they can drill down into the data.

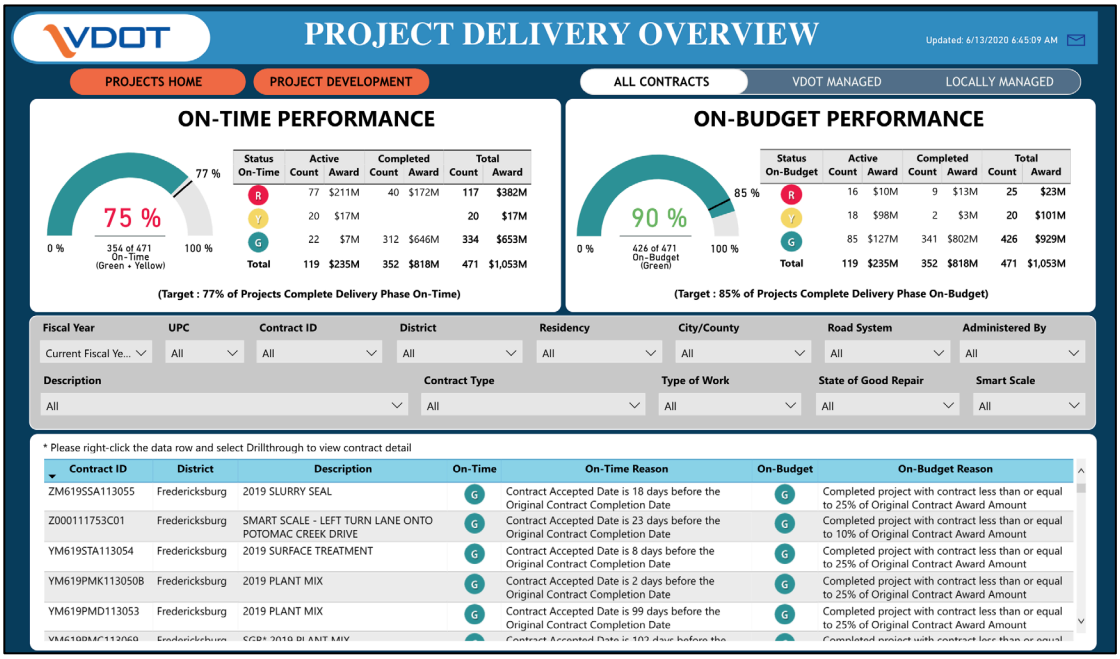



**Figure 3.15** Virginia DOT Project Delivery Dashboard

Table 3.18 lists the remaining performance measures tracked by VDOT. They are presented on the older Version 3.0 dashboard.

**Table 3.18** Virginia DOT Performance Measures

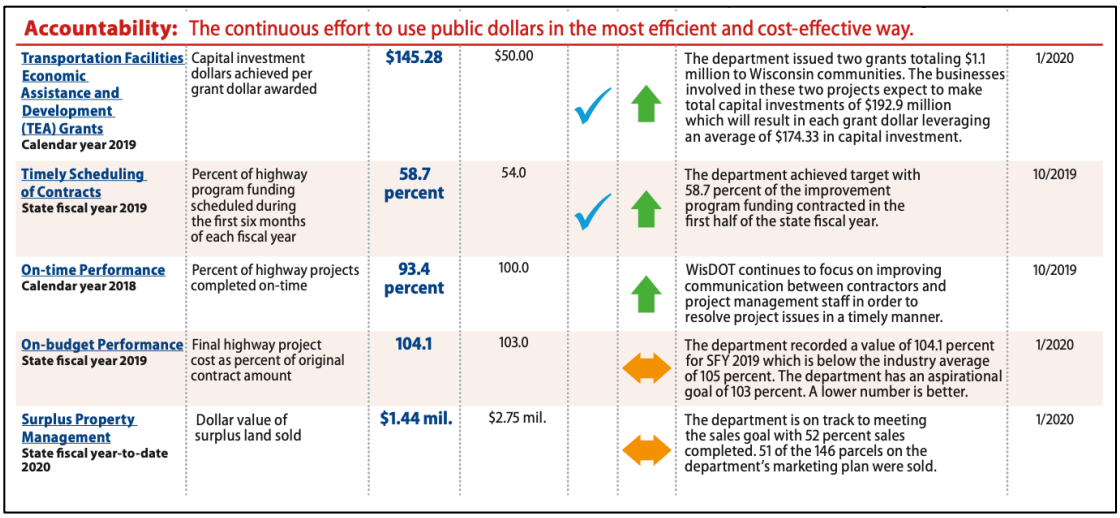
| **Highway Performance** |
|---|
| • Congestion at Selected Interstate Locations<br>• HOV Travel Speed Performance<br>• Travel Time on Key Commuter Routes<br>• Incident Duration<br>• Percent of Incidents Cleared by Time Category<br>• Annual Hours of Delay Per Traveler |
| **Safety** |
| • Crashes<br>• Injuries<br>• Deaths<br>• Work Zone Crashes |
| **Condition** |
| • Pavement Condition<br>• Bridge Condition<br>• Ride Quality |
| **Finances** |
| • Revenue<br>• Expenses<br>• Purchase Power<br>• Comparison of Forecasted and Actual Revenues and Expenditures |
| **Citizen Survey Results** |
| • Overall Satisfaction with VDOT |

Most of the dashboard focuses on asset conditions, but customer satisfaction is noted. It is measured through a Survey conducted by the Southeastern Institute of Research (SIR). SIR uses a random-digit telephone survey of 1,800 Virginians around the Commonwealth to measure trends in citizens' opinions with Virginia's transportation program and VDOT's performance. Highway performance is measured through congestion at selected interstate locations, travel time and speed (greater than or less than 45 mph), incident duration and percentage cleared by time (incidents of less than 10 minutes are not included; all other incidents are reported as less than 30 minutes, 30 to 60 minutes, 60 to 90 minutes, and more than 90 minutes), and annual hours of delay which is based on the Texas Transportation Institute's annual Urban Mobility Report (UMR).

### 3.2.11 Wisconsin

The Wisconsin DOT's (WisDOT) performance improvement program focuses on the areas of mobility, accountability, preservation, safety, and service (abbreviated MAPSS). A primary goal of MAPSS is to collect data on performance measures that will help WisDOT deliver programs and services efficiently to its customers. As part of this initiative, the agency tracks several measures related to highway construction project development and delivery. Each quarter, WisDOT publishes MAPSS Performance Improvement Program reports, which describe performance measurement findings.[22] Each report leads off with a high-level performance scorecard that summarizes data for each metric, including measurement procedures, goals, whether that goal has been met, trendlines, comments, and most recent reporting period. Figure 3.16 captures a portion of this scorecard for accountability performance measures, most of which are related to project delivery.

[22] WisDOT maintains an archive of MAPSS reports at:
https://wisconsindot.gov/Pages/about-wisdot/performance/mapss/mapss-archives.aspx



**Accountability:** The continuous effort to use public dollars in the most efficient and cost-effective way.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Transportation Facilities Economic Assistance and Development (TEA) Grants<br>Calendar year 2019 | Capital investment dollars achieved per grant dollar awarded | $145.28 | $50.00 | ✓ | ↑ | The department issued two grants totaling $1.1 million to Wisconsin communities. The businesses involved in these two projects expect to make total capital investments of $192.9 million which will result in each grant dollar leveraging an average of $174.33 in capital investment. | 1/2020 |
| Timely Scheduling of Contracts<br>State fiscal year 2019 | Percent of highway program funding scheduled during the first six months of each fiscal year | 58.7 percent | 54.0 | ✓ | ↑ | The department achieved target with 58.7 percent of the improvement program funding contracted in the first half of the state fiscal year. | 10/2019 |
| On-time Performance<br>Calendar year 2018 | Percent of highway projects completed on-time | 93.4 percent | 100.0 | | ↑ | WisDOT continues to focus on improving communication between contractors and project management staff in order to resolve project issues in a timely manner. | 10/2019 |
| On-budget Performance<br>State fiscal year 2019 | Final highway project cost as percent of original contract amount | 104.1 | 103.0 | | ↔ | The department recorded a value of 104.1 percent for SFY 2019 which is below the industry average of 105 percent. The department has an aspirational goal of 103 percent. A lower number is better. | 1/2020 |
| Surplus Property Management<br>State fiscal year-to-date 2020 | Dollar value of surplus land sold | $1.44 mil. | $2.75 mil. | | ↔ | The department is on track to meeting the sales goal with 52 percent sales completed. 51 of the 146 parcels on the department's marketing plan were sold. | 1/2020 |

**Figure 3.16** Wisconsin DOT MAPSS Scorecard

Data sheets for individual performance measures contain additional information, including reporting frequency, a more through explanation of why the performance measure is important, targets, figures which capture historical trends, factors which can influence results, and steps WisDOT is taking to improve its performance. Eleven of the performance measures tracked by the agency relate in some capacity to project development and delivery (Table 3.19). Most of these are similar to metrics tracked by other agencies (e.g., on-time and on-budget performance), but there are unique ones, including one focused on design quality and another on the disposal of surplus property.

**Table 3.19** Wisconsin DOT Project Development and Delivery Performance Metrics

| Performance Measure | Description | WisDOT Target |
|---|---|---|
| TEA Grants | • TEA grants offer state matching grants up to 50 percent (maximum of $5,000 per job) to help governing bodies pay for projects that will attract and retain employers | $50 of capital investment for each $1 of grant funds awarded |
| Timely Scheduling of Contracts | • Percentage of improvement program funding contracted during the first half of the fiscal year<br>• Goal is to increase competitive bids, allow the department to adjust lettings in the final half of the fiscal in response to contract savings/overages, and let the department expend any federal funds received late in the year | Contact 54 percent of program improvement funds in the first half of the state fiscal year |
| On-Time Performance | • Percentage of construction projects completed within the specified timeframe and agreed-upon extensions | 100 percent of projects delivered on time |
| On-Budget Performance | • Compares final construction cost (excepting engineering and project oversight) to the original contract amount of all projects completed during the fiscal year | Actual project costs should not exceed original contract by more than 3 percent |
| Surplus Property Management | • Revenue generated from the sale of property no longer needed for transportation improvement project | Generate $2.75 million in revenue each state fiscal year |

| | | |
|---|---|---|
| Damage Claims Collections | • Reimbursements to state highway maintenance fund collected from negligent drivers who damage state highway property | Between 65 and 90 percent of the original invoice amount (varies by year) |
| Design On Time (Local System) | • Percentage of state-let local projects with Plans, Specification, and Estimates documents submitted by the end of the state fiscal year planned at time of project scoping | Deliver 85 percent of projects in the fiscal year they are originally scheduled |
| Design Quality | • Measured of the completeness of a project plan made by a construction project leader and contractor<br>• Measure consists of an index that combines multiple design elements (rated on a scale from 1 [lowest] to 7 [highest]) | 80 percent |
| Engineering Estimate Accuracy | • Compares the engineer's estimate to the low bid price and determines the percentage of contracts within 10 percent of the construction cost estimate | 60 percent of estimates within 10 percent of the low bid |
| Statutory Chapter 16 Minority Business Enterprise Spending | • Total state-certified MBE spending divided by total agency spending within interagency, intergovernmental, and Chapter 84 transactions not in scope | At least 5 percent of spending with state-certified MBEs |
| Design On Time (State System) | • Percentage of projects delivered in the fiscal year they are originally scheduled | 90 percent |

Adams et al. (2003) developed a set of winter performance measures for Wisconsin based on GPS sensors and receivers. The measures are divided into state and county level approaches and are then categorized first by a goal and then an objective, with performance measures providing information on how well the goals and objectives are being met. Focusing on statewide measures, Table 3.20 is reproduced in part from Adams et al.

**Table 3.20** Statewide Winter Performance Measures

| Goal | Objective | Performance Measure |
|---|---|---|
| Evaluate trends over multiple seasons | Calculate annual winter severity index | Winter severity index |
| Minimize Environmental Impacts | Monitor application guideline compliance by patrol section | Hourly average pavement temperature for each patrol section |
| | | Hourly average application rate of salt (pounds/lane mile) for each patrol section |
| | | Hourly average application rate of sand (pounds/lane mile) for each patrol section |
| | | Hourly average application rate of prewetting liquid added to salt (gals/ton) for each patrol section |
| | | Hourly average application rate of prewetting liquid added to sand (gals/ton) for each patrol section |
| | | Hourly average application rate of anti-ice liquid (gals/lane mile) for each patrol section |

| | | |
|---|---|---|
| | Monitor application guideline compliance by operator and event | Blasts for each operator and event |
| | | Average application rate of salt (pounds/lane mile) for each operator and for each event |
| | | Average application rate of sand (pounds/lane mile) for each operator and for each event |
| | | Average application rate of prewetting liquid added to salt (gals/ton) for each operator and for each event |
| | | Average application rate of prewetting liquid added to sand (gals/ton) for each operator and for each event |
| | | Average application rate of anti-ice liquid (gals/lane mile) for each operator and for each event |
| Manage annual winter maintenance budget | Monitor material cost by event and patrol section | Tons of salt used for each event and patrol section |
| | | Cubic yards of sand used for each event and patrol section |
| | | Gals of prewetting liquid used for each event and patrol section |
| | | Gals of anti-ice liquid used for each event and patrol section |
| | | Storm severity index |
| | Monitor equipment cost by event and patrol section | Cost for all attachment units for each event and patrol section |
| | | Storm severity index |
| | Monitor labor cost by event and patrol section | Overtime hours for each event and patrol section |
| | | Labor cost (including overtime & clean-up) for each event |
| | | Storm severity index |

### 3.2.12 Georgia

The Georgia DOT (GDOT) relies on performance-based management reporting — dubbed MilePosts — that is designed to capture how well the agency is meeting its goals and objectives. Areas in which performance does not meet objectives can be targeted for improvement. GDOT has used performance measures for a little over 10 years, and currently monitors over 250 measures across the department (Duncan et al. 2018). An online dashboard lets visitors see how the agency is performing in several strategic areas. The agency encourages divisions and districts to implement sub-measures that capture the ways in which they are deepening efforts to meet performance targets. District offices have access to the data used to generate statistics reported on the dashboard, which lets them identify where information is sourced from and strategize about how they can influence them. Each quarter, the agency publishes a quarterly newsletter that includes high-level performance data. It also releases an annual *Accountability and Investment Report* that includes information on funding sources, how funding is used, system performance (e.g., safety and reliability), project delivery performance, infrastructure condition, major projects in each district.[23] The report contains statistics on the following project delivery metrics: projects constructed on schedule, projects constructed on schedule that include supplemental agreements, projects constructed under budget, projects constructed on budget, and projects constructed both on and under budget. Figure 3.17 illustrates how these metrics are presented in the annual report and Figure 3.18 shows how GDOT tracks system reliability through measures such as motorist assists and average freeway speeds in metro Atlanta.

[23] The most recent version can be found here: http://www.dot.ga.gov/AboutGDOT/TheNetwork/Publications

| FY 2019 | Q1<br>July - September | Q2<br>October - December | Q3<br>January - March | Q4<br>April - June | FY Total |
|---|---|---|---|---|---|
| Percentage of projects constructed **on schedule** (Original Time) | 62%<br>= 29 (on schedule) of 47 (total projects) | 61%<br>= 25 (on schedule) of 41 (total projects) | 47%<br>= 27 (on schedule) of 57 (total projects) | 60%<br>= 24 (on schedule) of 40 (total projects) | 57%<br>= 105 (on schedule) of 180 (total projects) |

*Revised based on updated data due to additional analysis and processing.*

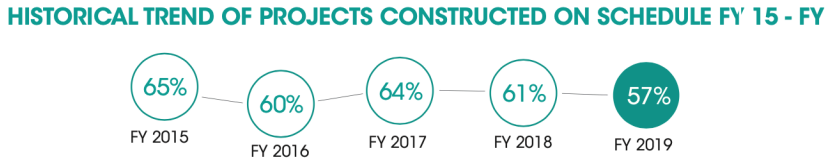



**Figure 3.17** Georgia DOT On-Time Project Delivery Performance

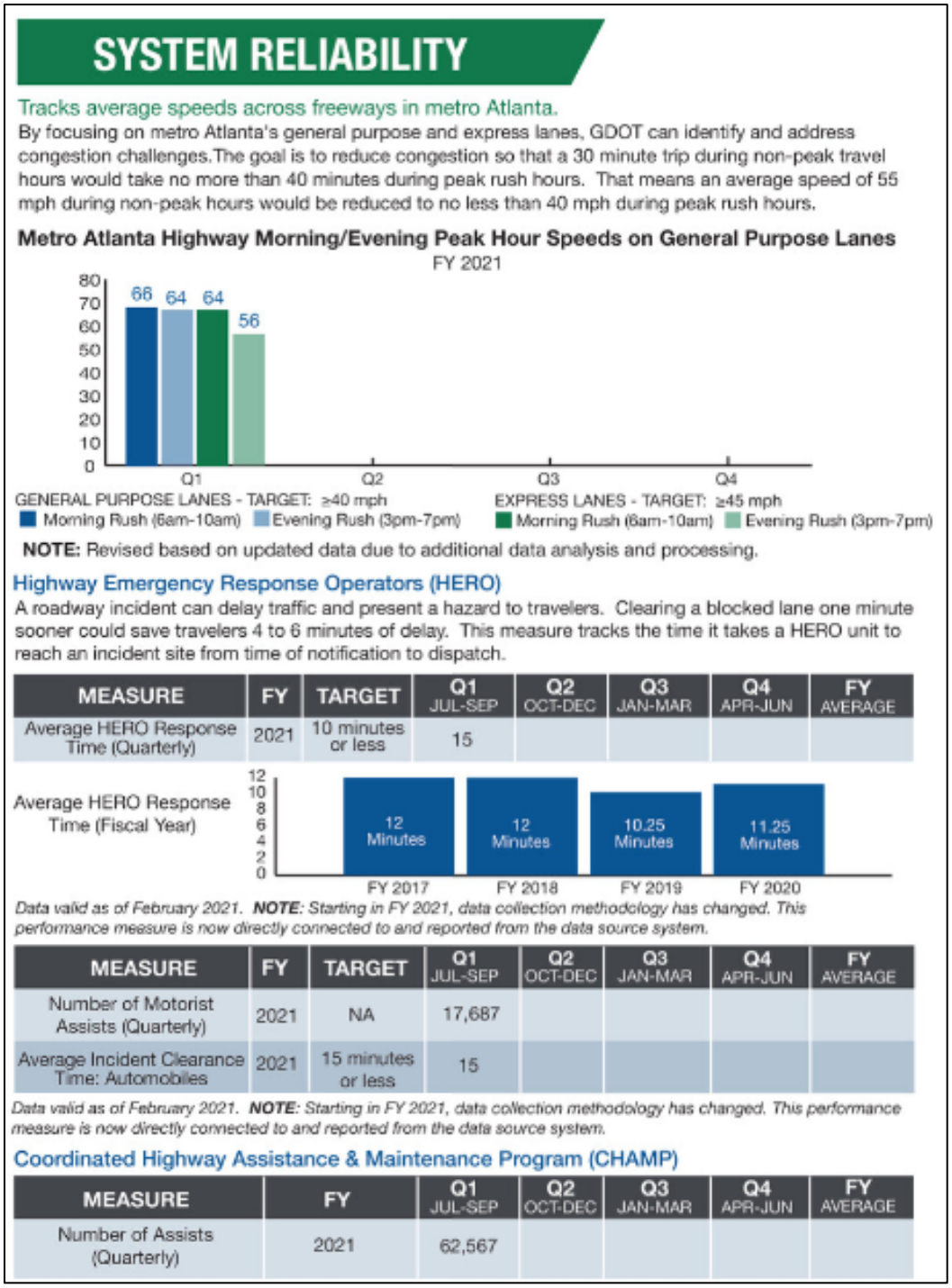



**Figure 3.18** Georgia DOT System Reliability Measures

Like many agencies, GDOT grounds all of its operations in a data-driven performance management philosophy. Performance measures are reviewed each year, including their definition and methods of calculation, to verify they remain strongly tied to agency's mission. Furthermore, GDOT's Commissioner, Deputy Commissioner, Chief Engineer, and Treasurer review strategic measures quarterly. If measures require adjustment, changes are made in a cooperative and collaborative manner (Duncan et al. 2018). The agency is also in the midst of developing new dashboards for tactical-level measures that will only be available to internal stakeholders. One interesting feature of GDOT's performance management program is that individual staff are evaluated based on how well the

performance measures they have been assigned responsibility for are doing. Performance measures are included in each employee's performance plan to establish personal accountability in strategic areas.

### 3.2.13 Florida

The Florida DOT (FDOT) has adopted a number of performance management initiatives.[24] Key products generated through its efforts include the *Performance and Production Review of the Florida Department of Transportation*, an annual performance report which reviews the agency's performance and is used to inform decisions and feedback on FDOT's performance, the *ITS Performance Measures Annual Report*, customer satisfaction surveys, and the *FDOT Source Book*. The Office of Construction also publishes performance measurement results each quarter. Information is available dating to the mid-1990s. Table 3.21 lists and describes the measures which are part of this report. Measures are reported at the aggregate level and deal with issues such as cost and time variance, time to acceptance, and cost and time expenditures that could have been avoided.

**Table 3.21** Florida DOT Construction Office Performance Measures

| Measure | Description |
|---|---|
| Number of Contracts | • Number of contracts passed during the quarter |
| Total Original Amount | • Value of all contracts (minus contingency amount) passed during the quarter |
| % Time Increase | • Increase in time over original days expressed as a percentage of the Original Days |
| % Contracts < 20% Increase in Time | • Percentage of contracts where actual days used less weather days and holidays did not exceed the Original Days by more than 20% |
| % Cost Increase | • Increase in cost over the original contract amount as a percentage of the original contract amount |
| % Contracts < 10% Increase in Cost | • Percentage of contracts for which actual expenditures did not exceed the original contract amount (minus contingencies) by more than 10% |
| % Total CEI | • Cost for all construction engineering and inspection as a percentage of the present contract amount |
| Total Avoidable Premium Cost | • Non-value added cost for all contract changes that could have been avoided |
| Avoidable Cost % | • Added cost for all contract changes that could have been avoided as a percentage of the original contract amount |
| Avoidable Time % | • Days added to contract for all contract changes that could have been avoided as a percentage of the original contract days |
| Days to Initial Offer | • Number of days between the Contract Final Accepted date and the Initial Final Offer of Payment Date by FDOT |
| Days to Project Passed | • Number of days between Contract Final Accepted Date and the Contract Pass date |
| Number of Contracts Reaching Final Acceptance | • Number of contracts that reached Final Acceptance Status during the quarter |
| % of Contracts/CPPR Grades Within 45 Days | • Percentage of contracts reaching Final Acceptance that had CPPR Grades entered within 45 days of Final Acceptance |
| % Average Absolute Change Post Audit Review | • Absolute change in contract amount value for Post Audit Reviews by CCEI and in-house CEI |

[24] Links to programs and publications can be found at: https://www.fdot.gov/planning/performance/default.shtm

The *Performance and Production Review of the Florida Department of Transportation* addresses performance in areas such as condition of the highway system, capacity improvements, safety initiatives, financial administration, and production business practices. Under the latter category (in addition to metrics listed in Table 3.21), the agency tracks additional measures, including consultant contract dollars executed as a percentage of the original estimate; percentage of consultant contracts executed; and percentage of Right of Way projects certified relative to number of projects scheduled for certification. The *FDOT Source Book* provides information on characteristics of Florida's transportation system and numerous performance measures, which are grouped into several categories: factors affecting mobility and multimodal mobility; safety, people-, and freight-related measures; and forecasted measures. This report does not address project development and delivery, and its primary focus is on issues like injuries and fatalities, congestion and delay, transit usage, and vehicle miles traveled,. The *FDOT Source Book*'s layout is intuitive and user-friendly. Results for each performance measure are summarized on one page. Write-ups describe what the performance measure calculates, methods of calculation, reporting periods, comments on recent historical trends, and line graphs and bar charts that depict those trends (Figure 3.19). Mobility measures are detailed in Table 3.22 and are more comprehensive than many other states. FDOT, however, lacks a dedicated online dashboard that summarizes data at a high level.

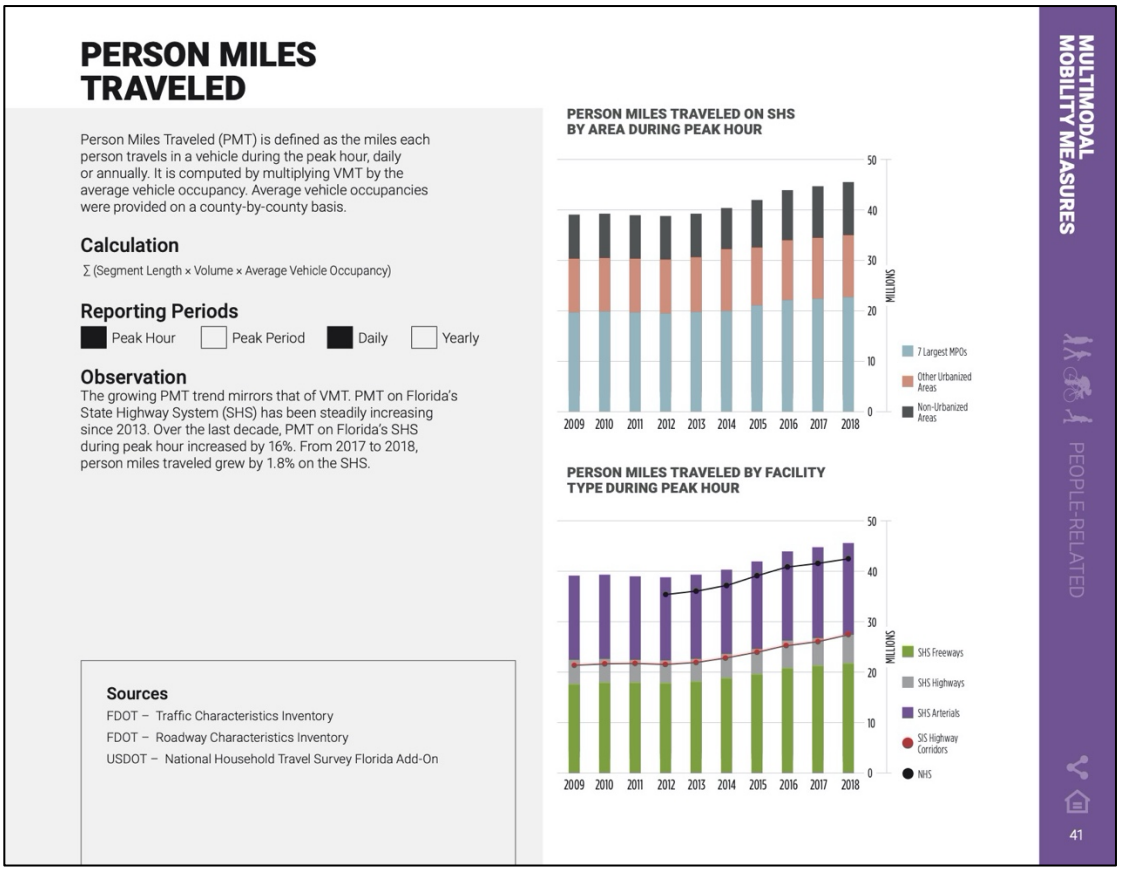



**Figure 3.19** Florida DOT Source Book Layout

**Table 3.22** Florida DOT Source Book Mobility Measures and Methodologies

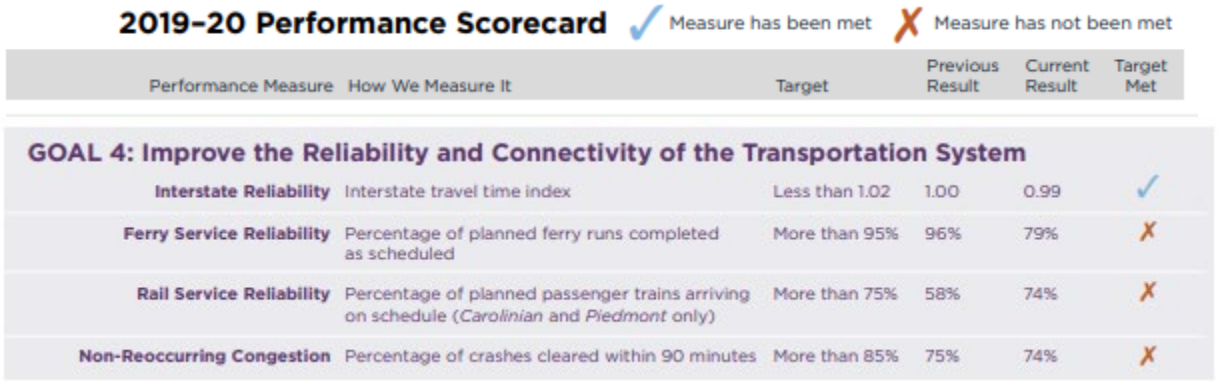
| Auto Mobility Measure | Methodology |
|---|---|
| Vehicle Miles Travelled | • Daily vehicle volume was directly obtained from annual average daily traffic (AADT), while the peak hour volume was the product of the AADT and the highest hourly factor. Vehicle miles traveled (VMT) was determined using vehicle traffic volume and segment length. The number of VMT was based on data obtained from traffic monitoring sites and Florida Department of Transportation's (FDOT's) Roadway Characteristics Inventory (RCI) Feature 111 data.<br>• Calculation<br>• VMT=Σ(Segment Length × Volume) |
| % Travel Meeting Level of Service Targets | • The percent of travel meeting Level of Service (LOS) targets is determined by summing the Vehicle Miles Traveled (VMT) on roadways operating acceptably and then dividing by the total system VMT. "Acceptably" is defined as LOS D for all urbanized areas and LOS C for all other areas. 5:00 p.m.-6:00 p.m. on a weekday is considered as peak hour; 4:00 p.m.-6:00 p.m. on a weekday is considered as peak period.<br>• Calculation<br>• Σ(VMT during Peak Performance ≥ Acceptable LOS Target Threshold)Σ VMT×100 |
| % Miles Meeting Level of Service Targets | • The percent of miles meeting LOS targets is determined by summing the centerline miles of roadway operating acceptably and then dividing by the total system centerline miles. "Acceptably" is defined as LOS D for all urbanized areas and LOS C for all other areas. 5:00 p.m.-6:00 p.m. on a weekday is considered as peak hour; 4:00 p.m.-6:00 p.m. on a weekday is considered as peak period.<br>• Calculation<br>• Σ(Segment Length during Peak Performance ≥ Acceptable LOS Target Threshold)Σ Segment Length×100 |
| Travel Time Reliability: On Time Arrival | • For the urbanized areas of the 7 largest MPOs, on-time arrival is defined as the percentage of freeway trips traveling at least 45 mph. For all others, on-time arrival is defined as the percentage of freeway trips traveling at greater than or equal to 5 mph below the posted speed limit during the peak hour. For example, 80% on-time arrival indicates that the traveler is anticipated to arrive at the destination on time on 4 out of 5 trips.<br>• Calculations<br>  • The on-time arrival for urbanized areas of the 7 largest MPOs was computed using the following equation:<br>  Σ(VMT at a Travel Speed ≥ 45 mph)Σ VMT×100Σ(VMT at a Travel Speed≥45 mph)Σ VMT×100 |

| | |
|---|---|
| | • The on-time arrival for all other areas was computed using the following equation:<br>• Σ(VMT at a Travel Speed ≥ Speed Limit - 5 mph)Σ VMT×100 |
| Travel Time Reliability: Planning Time Index | • Planning Time Index (PTI) is defined as the ratio of the 95th percent peak period/hour travel time to the free flow travel time. This measure represents the additional time that a traveler should budget to ensure on-time arrival 95 percent of the time.<br>• Calculation<br>• Travel Time 95th percentile Travel Time free flow |
| Vehicle Hours of Delay | • Vehicle hours of delay was estimated on an hourly basis by determining the difference between delay threshold travel time and actual travel time along a facility. Delay threshold travel time/speed is considered the additional travel time experienced by a motorist beyond what would be experienced under uncongested conditions. The definition of uncongested conditions was defined as level of service "B". Delay estimation considers unserved demand from the preceding hours for the time periods between 7:00 a.m. and 10:00 a.m. and between 4:00 p.m. and 7:00 p.m.<br>• Calculation<br>• Σ(Daily or Peak Travel Time-Travel Time at LOS B) × Vehicle Volume |
| Average Travel Speed | • The length of the highway segment divided by the average travel time of all vehicles traversing the segment, including all stopped times. Average travel speed is the average of all hourly segment travel speeds captured by probe data or modeled through speed-volume functions.<br>• Calculation<br>• Σ(VMT × Average Travel Speed)Σ VMT |
| % Travel Heavily Congested | • The percent of travel heavily congested was determined by summing the vehicle miles traveled on roadways operating at defined LOS thresholds and then dividing it by the total system vehicle miles traveled.<br>• Calculation<br>• Σ(VMT during Peak Performance at defined LOS thresholds)Σ VMT × 100 |
| % Miles Heavily Congested | • The percent of miles heavily congested for all vehicles and for combination trucks is determined by summing the miles of roadway operating at defined LOS thresholds in the peak hour/peak period and then dividing it by the total system miles.<br>• Calculation<br>• Σ(Segment Length during Peak Performance at defined LOS thresholds)Σ Segment Length × 100 |

Source: http://fdotsourcebook.com/

### 3.2.14 North Carolina

The North Carolina DOT (NCDOT) positions itself as a performance-based organization with a decision-making process informed by strategies and data analysis. In sticking to data-driven decision making, the goal is to keep politics out of transportation project selection. The Strategic Transportation Investments Law was passed in 2013 and gave rise to the Strategic Mobility Formula, a scoring process that uses data and local input to allocate funding. NCDOT tracks 26 executive performance measures that align with its six stated goals of making transportation safer, providing superior customer service, delivering and maintaining infrastructure efficiently and effectively, improving the transportation system's reliability and connectivity, promoting economic growth through better use of infrastructure, and making the agency a great place to work. Performance is summarized in an annual report as well on as an online dashboard.[25]



**2019–20 Performance Scorecard** ✓ Measure has been met ✗ Measure has not been met

| Performance Measure | How We Measure It | Target | Previous Result | Current Result | Target Met |
|---|---|---|---|---|---|
| **GOAL 4: Improve the Reliability and Connectivity of the Transportation System** | | | | | |
| **Interstate Reliability** | Interstate travel time index | Less than 1.02 | 1.00 | 0.99 | ✓ |
| **Ferry Service Reliability** | Percentage of planned ferry runs completed as scheduled | More than 95% | 96% | 79% | ✗ |
| **Rail Service Reliability** | Percentage of planned passenger trains arriving on schedule (*Carolinian* and *Piedmont* only) | More than 75% | 58% | 74% | ✗ |
| **Non-Reoccurring Congestion** | Percentage of crashes cleared within 90 minutes | More than 85% | 75% | 74% | ✗ |

**Figure 3.20** North Carolina DOT Annual Performance Scorecard

Figure 3.20 is a snapshot of NCDOT's scorecard focused on reliability and connectivity. NCDOT also measures customer satisfaction through an annual survey of 2,300 respondents; Figure 3.21 shows the customer satisfaction dashboard.

[25] https://www.ncdot.gov/about-us/our-mission/Performance/Pages/delivery-rate.aspx

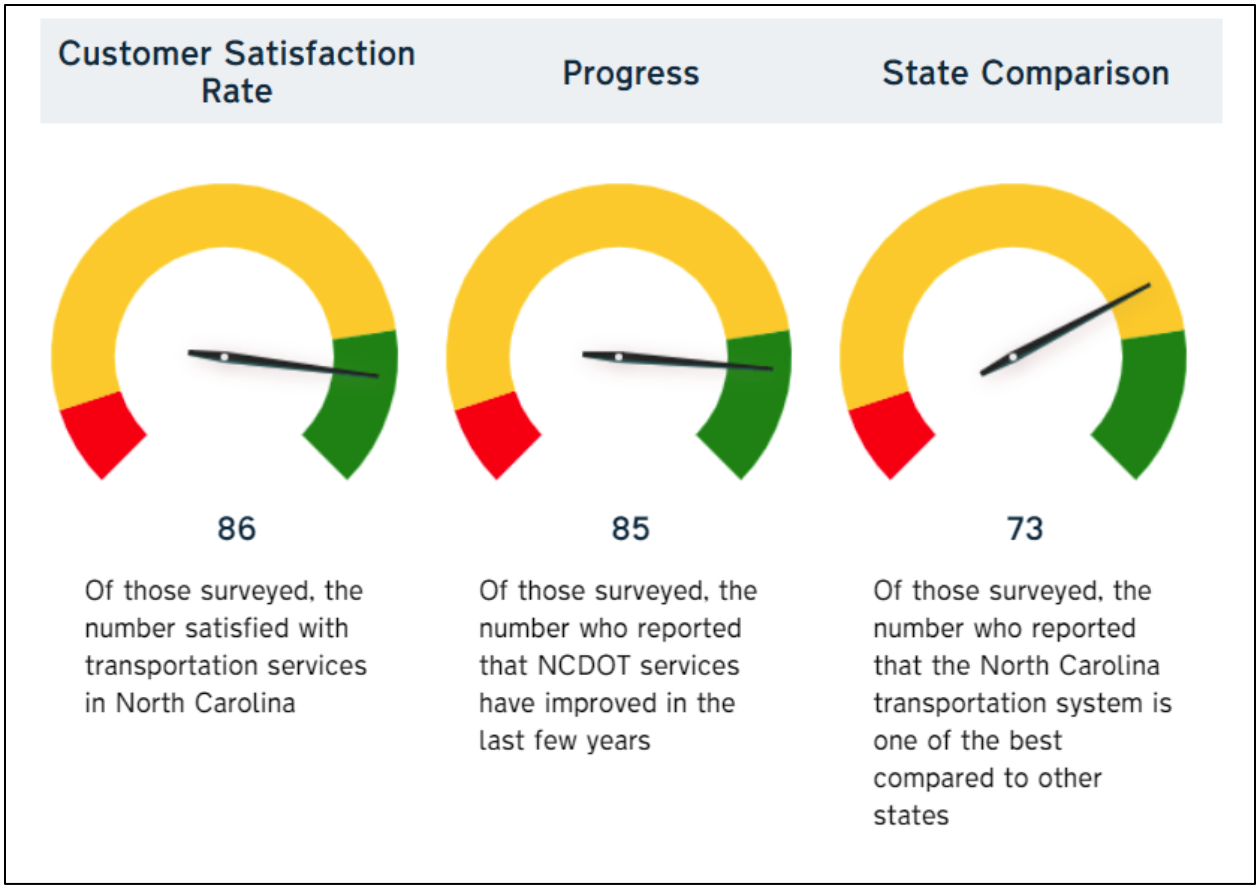



**Figure 3.21** North Carolina DOT Customer Satisfaction

Duncan et al. (2018) observed that the agency evaluates staff partially on objective performance measures related to their responsibilities. While originally NCDOT shifted to a 100 percent data-driven evaluation model, this was abandoned because the agency recognized that personnel could be held responsible for issues that lie beyond their control. Now 50 percent of evaluations are based on performance metrics.

North Carolina also initiated a survey through AASHTO on key performance indicators other state DOTs use to measure technical services. The survey, which was in the field in January-February 2020, yielded 11 responses. A summary of the most pertinent responses is included in Appendix B. Generally, respondents noted the use of key performance indicators, although the substance and depth varied. Often, dashboards were utilized in some form with tracking of responsibilities remaining with individual units in some cases and delegated to a central unit in others.

# Chapter 4 Current Data Collection and Potential Performance Measures

## 4.1 KYTC Data Collection and Reporting

KYTC collects data on its maintenance and operations. For example, the Maintenance Rating Program (MRP) samples roadways across the state. Every year the program evaluates 300-400 segments 500 feet in length across four road types: interstates, National Highway System (non- interstate), state primary and secondary, and rural secondary. Collected data are available for numerous years, however, the MRP only provides data from a point in time.

KYTC's DataMart[26] is an interactive online repository of Cabinet data created in response to MAP-21 requirements that:

1) Provides a central portal for accessing transportation data
2) Automates and displays regularly scheduled reporting
3) Provides transparency into and public accountability for the Cabinet's management and stewardship of public funds

Data are stored for the following categories: county, roads, bridges, traffic, vehicle, safety, fiscal, documents, and spatial along with an advanced queries option. Table 4.1 summarizes data available in each category. As a source of high-level aggregate data it serves a useful function and could be customized to report on performance measures as well (e.g., the current *Kentucky Strategic Highway Safety Dashboard*).

**Table 4.1** KYTC DataMart Descriptions

| Category | Description |
|---|---|
| County | County snapshots, including population, highway district, crashes, state-maintained lane miles, KYTC employees, Road Fund dollars authorized and spent, vehicle registrations by type |
| Roads | Data on current construction; links to the Highway Plan, HIS Database, NHS information, functional classifications, and the Coal Haul Highway System |
| Bridges | Definitions of bridge terms, link to Bridge Portal, information on weight-posted bridges. |
| Traffic | Traffic counts, data station locations, and statewide traffic count maps; Continuous Count Station Information downloads available via Excel files; Highway Performance Monitoring System reports |
| Vehicle | Breakdown of statewide vehicle registrations by category, type, fuel type; county-level breakdowns also available |
| Safety | Kentucky Strategic Highway Safety Dashboard, Daily Fatality Statistics, yearly summaries, and problem ranking maps from the Kentucky Office of Highway Safety; links to relevant Incident Management material such as weather conditions and snow and ice maps |
| Fiscal | Budget documents and financial reports to management from FY12-13 to present; data on total KYTC employees from 1975 to present |
| Documents | Links to documents, including the Enacted and Recommended Highway Plans, past plans, policy manuals, the current STIP, TAM Plan, Statewide Corridor Plan, Long-Range Statewide Transportation Plan, planning studies and reports, and standard drawings |
| Spatial | Shapefiles and geospatial data for download |

The Kentucky Office of Highway Safety (KOHS) publishes dashboards through DataMart focused on the *2020-2024 Strategic Highway Safety Plan*.[27] Dashboards contain statistics on the plan's emphasis areas — distracted driving, aggressive driving, impaired driving, occupant protection, roadway departure, and vulnerable road users. It focuses on the plan's performance measures as well: "The annual safety performance measures represent all public roads

[26] http://datamart.business.transportation.ky.gov/

[27] https://transportation.ky.gov/HighwaySafety/Documents/2020%20SHSP%20SAFE%20KY%20Highway%20Safety%20Plan%20Final%205-20.pdf

and are reported as five-year rolling averages for the following measures: Fatalities, Fatality Rate, Serious Injuries, Serious Injury Rate, and Non-Motorized Fatalities and Serious Injuries."[28]

Kentucky's Roadway Weather Information System (RWIS) "provides information to the Cabinet's maintenance engineers to assist them in deciding what method and what type of chemicals should be used to remove snow and ice. Other users of the system include the National Weather Service, local meteorologists, public schools and universities."[29] RWIS data include air, pavement, and subsurface temperatures, dew point, solar radiation, precipitation, and wind direction and speed. Data are collected at 39 sites across Kentucky.

GoKY.ky.gov is an online portal with real-time traffic and road condition information, including incident and construction alerts, traffic speeds, and other pertinent information, such as links to Waze, HERE, TRIMARC (Traffic Response and Incident Management Assisting the River Cities), and National Weather Service pages. This interface replaced the 511 system (Van Dyke et al. 2016). The associated webmap displays layers for District Weather Alerts, County Weather Alerts, KYTC — Snow and Ice Priority Routes, Dynamic Messages, Cameras, Alerts (Waze), Alerts (Crashes Only), Alerts (KYTC TRIMARC), Alerts (KYTC TOC), Alerts (KYTC TOC), Traffic Speeds, and Traffic. It also has information on KYTC's responses to snow and ice events, including snowfall from CoCoRahs, layers for districts and counties with air temperatures from Kentucky Mesonet, pavement temperatures from RWIS, emergency snow and ice routes, snow and ice control activities (county level), traffic cameras, and traffic alerts (e.g., Waze, TRIMARC) and speeds (congestion).

The Snow and Ice Decision Support Dashboard consolidates millions of records per day from 11 data sources, particularly during snow and ice events. The dashboard includes the same snow and ice information found on GoKy.ky.gov as well as other that can improve decision making, such as facility locations, a crash layer that consolidates incident reports, Waze alerts filtered by specific meteorological reports (e.g., freezing rain, heavy snow), a congestion layer that includes HERE and Waze data, and District plans for the next 12-24 hours of an event. Automated Vehicle Locations (AVL) data on treated roadways includes air and pavement temperatures; dewpoints; wind speed; a KYTC calculated severity index; Doppler radar value; pre- and dry treatments and patrol data with timestamps, costs, event rate; maintenance county activity reports, and National Weather Service forecasts. Beyond snow and ice events, Waze traffic speeds and incident reporting, HERE traffic speeds, and Traffic Management Center (TMC) reporting can be used to analyze incident detection and reporting, work zone impacts, and high-crash areas where safety countermeasures may be useful.

The Division of Maintenance's Operations and Pavement Management Branch "collects objective data to measure the condition of KYTC assets, report system performance and analyze maintenance budgetary needs."[30,31] Data programs include pavement management and the Operations Management System (OMS). Pavement management includes data on pavement conditions, needs, and performance as well as information about data collection programs on pavement performance. Pavement condition data are collected on interstates, parkways, MP (non-Interstate and Parkway State Primary pavement, State Secondary pavement and Supplemental pavement), and rural secondary roads. Data publicly available for all road types include Historical Average Statewide Roughness (measured by the International Roughness Index (IRI)) and the Historical Percentage of Good, Fair, and Poor Pavements. Other data such as total mileage, average daily traffic, and age are available for many years. District-level roughness data and historical resurfacing program information are also available for MP and rural secondary roads. Most of these data have not been updated in public-facing media since 2015.

[28] https://datamart.kytc.ky.gov/SafetyDashboard.html
[29] http://rwis.kytc.ky.gov/
[30] https://transportation.ky.gov/Maintenance/Pages/Operations-and-Pavement-Management.aspx
[31] "Automated data collection is conducted annually on the Interstate and NHS routes, and on a two year cycle for all non-NHS routes. Average yearly collection is 35,000 lane miles. This data collection includes automated pavement distress, rutting, cross slope, IRI, faulting, curve & grade, GPS data, and roadway images." https://transportation.ky.gov/Maintenance/Pages/Pavement-Data-Collection.aspx

Annual condition reports are published that discuss statewide pavement conditions, interstate and parkway pavement conditions, and MP pavement conditions. The Statewide Pavement Condition Report, *MP Pavement Condition Report*, and the *Interstate and Parkway Pavement Condition Report* cover total investments in the system, review the pavement sustainability ratio (must equal 1 to maintain current conditions), pavement condition, and preservation liability demonstrating pavement needs. The reports contain intuitive graphics and a discussion of each component analyzed.

The OMS has data on maintenance operations and provides details on costs, inventory and asset control, and tracking tasks. OMS Reports published by KTC every fiscal year contain details on and expenditure breakdowns for snow and ice, tree and brush removal, guardrail, activity spending by category, roadway function class spending, work orders, material inventory adjustments, and contract spending. As noted in the FY2020 report[32] (p. 5-6), OMS goals are to:

- Assess maintenance activities
- Provide data to make informed decisions
- Ensure alignment with KYTC's strategic plan
- Provide data for GASB-34[33]

OMS Reports contain graphs, tables, and other visuals that highlight activities in each area over the fiscal year, including district breakdowns for many. Additionally, some of the data in the reports can be combined to evaluate performance trends over time, although the reports themselves are restricted to looking at cumulative spending by year.

KYTC maintains a Mobility Analysis Team with members from Planning, Traffic Operations, and FHWA.[34] The team's goal is to "[develop, test, and evaluate mobility] analysis performance measures for Kentucky." Past efforts have used the *Highway Capacity Manual* and Highway Capacity Software, while more recent efforts include support for and use of Texas A&M Transportation Institute's Annual Urban Mobility Study,[35] which is discussed later in this chapter, multimodal level of service analysis, ITS data, and traffic simulations such as FHWA's CORSIM.[36] Other are data collected from TMCs like ARTIMIS in the Cincinnati area and TRIMARC in Louisville.

**4.2 Potential Performance Measures**

Attempts to select new performance measures for KYTC began with brainstorming what a more comprehensive performance measurement process would look like. Using FHWA's Transportation Performance Management Framework (Figure 3.2) as well as approaches noted in literature, we generated the roadmap shown in Figure 4.1; it includes several considerations, which are explained below. This establishes a framework by which performance measures already being collected can be gathered, reported, and used, while other measures can be identified and operationalized.

- Determine Strategic Direction
    - What is KYTC's mission and vision?
    - What are KYTC's goals and strategies for fulfilling its mission and vision?
- Identify Performance-Based Goals
    - Which agencies are KYTC's peers and what are they doing related to performance?
    - What criteria must the goals meet?
    - To succeed, management and employee input must be considered, and buy-in is critical.
    - What is the purpose of a performance program and goals?

[32] https://transportation.ky.gov/Maintenance/Documents/Annual%20Reports/OMS%20Report%20FY20.pdf
[33] https://www.gasb.org/st/summary/gstsm34.html
[34] https://transportation.ky.gov/Planning/Pages/Mobility-Analysis.aspx
[35] https://mobility.tamu.edu/umr/
[36] https://ops.fhwa.dot.gov/trafficanalysistools/corsim.htm

    - How do performance-based goals tie back to KYTC's strategic direction?
- Set Performance Measures
    - What are KYTC's targets?
    - What data does KYTC need for the measures chosen, and what are the data sources?
    - What formulas or calculations are necessary to compute performance measures?
    - Who is responsible for the measure(s), including gathering data and calculating the measure(s) (if necessary)?
    - How frequently are items measured (e.g., annually, monthly, daily)?
- Reporting and Communication
    - What method(s) are used to report results (e.g., dashboard, spreadsheet)?
    - Is the method chosen for reporting and communicating measures user-friendly?
    - What are the expectations for sharing results?
    - Engage stakeholders in the process, gathering feedback.
- Monitoring and Adjustment
    - How is KYTC responding to and addressing results? Are changes being made?
    - Is the information being used to assist decision-making processes?
    - Is the information informing decisions about funding and resource allocation?
    - Are there gaps in what is being reported that should be rectified to provide a more complete picture of organizational performance?
    - Does the performance measurement program effectively provide useful information to improve KYTC's performance?

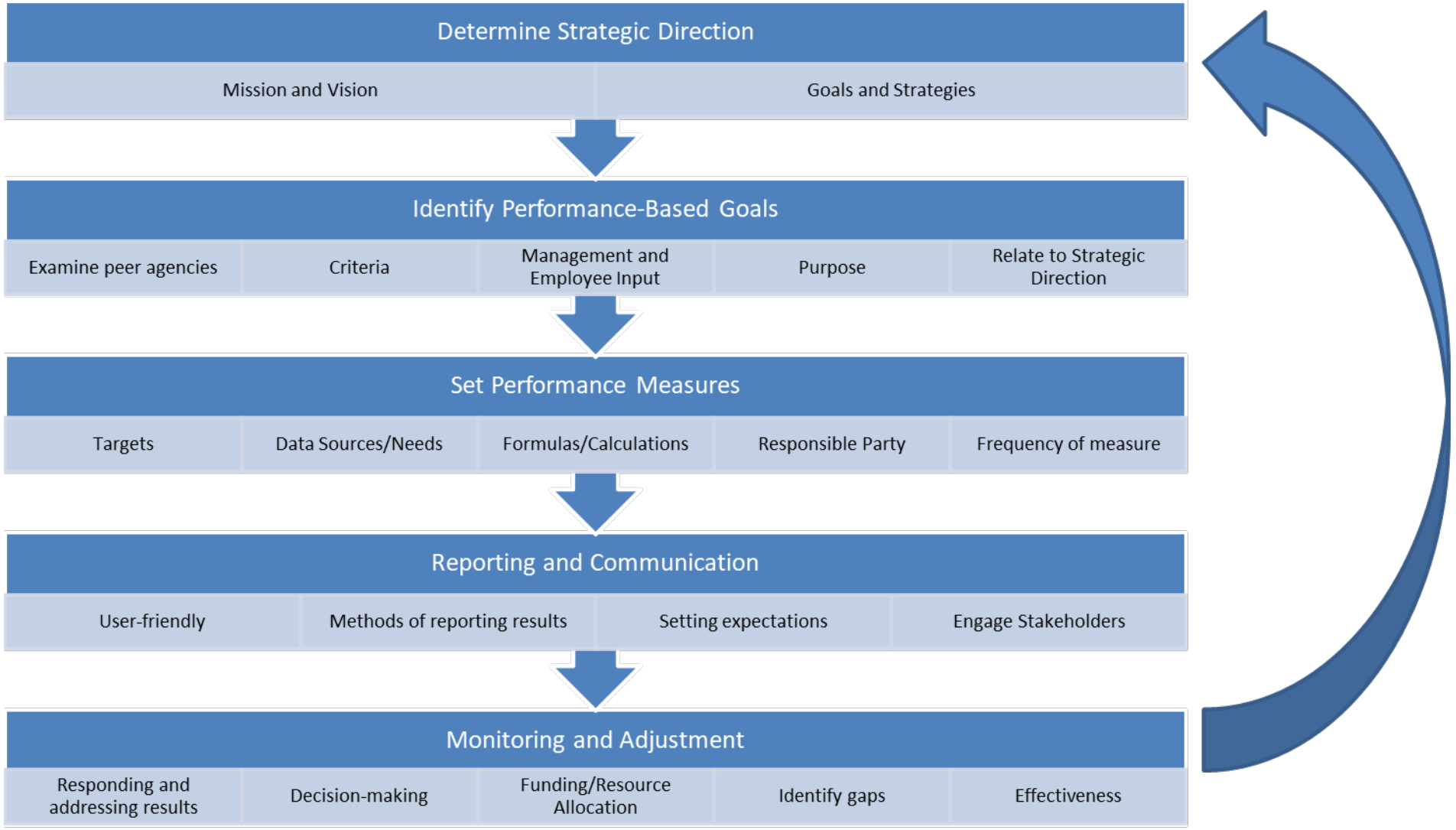



**Figure 4.1** Performance Measures Roadmap

Because the Cabinet felt confident in the performance measures used for asset condition, this section focuses on responsiveness and mobility. We identify performance measures KYTC could potentially implement. The FHWA-mandated measures listed in Table 3.1 (and reproduced in Table 4.2) are a useful starting point. These are found on its State Performance Dashboard and Reports, which includes performance data on safety, condition, reliability, emissions reductions, and congestion in urbanized areas.[37] Mobility is benchmarked based on reliability of interstate and non-interstate travel as well as truck travel time. However, Kentucky's targets are currently based on prior data analysis and the selection of a reasonable target versus a methodology for calculating a target. Highway reliability results can be viewed in Figure 4.2.

**Table 4.2** MAP-21 Performance Measures

| Safety |
|---|
| Number of Fatalities |
| Rate of Fatalities |
| Number of Serious Injuries |
| Rate of Serious Injuries |
| Number of Non-Motorized Fatalities and Non-Motorized Serious Injuries |
| **Infrastructure** |
| Percentage of Pavements of the Interstate System in Good Condition |
| Percentage of Pavements of the Interstate System in Poor Condition |
| Percentage of Pavements of the non-Interstate NHS in Good Condition |
| Percentage of Pavements of the non-Interstate NHS in Poor Condition |
| Percentage of NHS Bridges Classified in Good Condition |
| Percentage of NHS Bridges Classified in Poor Condition |
| **System Performance** |
| Percent of Person-Miles Traveled on Interstate That Are Reliable |
| Percent of Person-Miles Traveled on non- Interstate NHS That Are Reliable |
| Percent Change in Tailpipe $CO_2$ Emissions on the NHS cf. CY 2017 Levels |
| Truck Travel Time Reliability Index |
| Annual Hours of Peak Hour Excessive Delay per Capita |
| Percent of Non-SOV Travel |
| Total Emissions Reduction |

Kentucky 2020 Mid Performance Period Significant Progress Determination Results

| Measure Area | Measures | Baseline | Target | Actual | Better than Baseline? | Achieved Target? | Made Significant Progress? | Consequences [23 CFR 490.109(f)] |
|---|---|---|---|---|---|---|---|---|
| The performance of the Interstate System | Interstate Travel Time Reliability measure | 95.6 | 93.0 | 95.3 | No | Yes | Yes | None |
| Freight movement on the Interstate System | Freight Reliability measure | 1.24 | 1.25 | 1.24 | No | Yes | Yes | None |

**Figure 4.2** FHWA State Highway Reliability Results for Kentucky

However, these measures do not speak to issues of responsiveness and mobility. Accordingly, we selected measures and solicited opinions from within KYTC about which ones would provide the best gauge of performance for responsiveness and mobility. The Study Advisory Committee helped screen the proposed measures. Performance measures that fall under the responsiveness or mobility category are listed in Table 4.3. These could be further delineated by route type (e.g., interstates, NHS Routes, MP Routes). The aim is to merge ongoing efforts with some new measures to illuminate maintenance and operations performance. These measures could be considered as part of a comprehensive performance management program, using static and dynamic data. While the potential measures are generally static, with updates done annually, KYTC has made strides with dynamic, real-time big data — particularly related to snow and ice control and incident management — and these can be updated more frequently.

[37] https://www.fhwa.dot.gov/tpm/reporting/state/reliability.cfm?state=Kentucky

**Table 4.3** Potential KYTC Performance Measures

| Measures | Potential Data Source |
|---|---|
| Average response time for complaints (by type) | OMS |
| Pothole repair responsiveness | OMS |
| Drainage pipes and ditches — Percentage of time and money spent on routine maintenance | OMS |
| Drainage pipes and ditches — Percentage of time and money spent on emergency maintenance | OMS |
| Contract response time | OMS |
| Crew — Number of safety incidents | KYTC (Risk Management Services Company) |
| Guardrail and cable median barrier — Response time to repair damaged sections | OMS |
| Guardrail and cable median barrier — Cost and time to repair | OMS |
| Percentage of time and money spent on routine maintenance | OMS |
| Percentage of time and money spent on emergency maintenance | OMS |
| Snow and Ice Events- time to clear based on severity | KYTC Snow and Ice Decision Support Dashboard |
| Snow and Ice- cost per year/event (based on precipitation, number of events) | KYTC Snow and Ice Decision Support Dashboard |

Many of these address both mobility and responsiveness. For example, average incident clearance times are based on incident severity and response time. Some measures — like congestion and/or delay — are a function of or partially depend on other metrics (incident clearance times, average travel times, work zone impacts). These could be combined into an index or other comprehensive measure. Drawing from performance measures used in other states, Table 4.4 lists and defines other measures that may be considered.

**Table 4.4** Other Mobility and Responsiveness Measures for Consideration

| Measure | Definition |
|---|---|
| Vehicle Miles Travelled | On state highways |
| Average Incident Clearance Times | Based on duration (e.g., number of incidents that last 30-60 minutes, or clear crashes from roads within 60 minutes with the incident end when traffic speeds returned to normal or all vehicles are cleared from the roadway) |
| Reliability | Potential methods of measurement:<br>• Percentage of time a minimum speed is maintained on freeways<br>• Percentile of travel times (e.g., 50$^{th}$ percentile, 80$^{th}$ percentile; if the 80$^{th}$ percentile divided by the 50$^{th}$ percentile is > 1.5 travel times are unreliable)<br>• Percentage of miles on key routes that perform at historical speeds during peak periods<br>• Average speed during peak hours<br>• Ratio of the 95$^{th}$ percentile peak period/hour travel time over free flow travel time<br>Metrics can also apply to truck travel time reliability |

| | |
|---|---|
| Congestion | Indices such as total time needed to ensure on-time arrival, scaled where a 1 is optimal travel time as posted speed limit and if 40 minutes are needed to travel what is normally a 20 minute trip the score is 2 (40 minutes/20 minutes), traffic on freeways at less than 45 mph, percent of heavy congestion calculated by VMT at a level of service threshold and divide by total VMT |
| Delay | Number of hours of annual delay per person/driver |
| Customer Service | Generally measured by surveys; those satisfied with transportation or a similar metric |
| Work Zone Delays/Impacts | Additional time a work zone adds to normal travel<br>• Set a minimum threshold for inclusion (e.g., 5 minutes) |
| Average Travel Speeds | Average speeds by roadway types and segments if desired; set target |
| Annual delay per person | Total hours of delay divided by total number of drivers |
| Delay | Difference between actual travel time and travel time is traffic was flowing freely |
| Snow and ice clearance | Percent of time highways are clear of snow and ice during an event;<br>Time required to restore clear roadway conditions following an event (may be impacted by severity and duration) |
| Snow and ice mobility | Percentage of time precipitation is on the road in a liquid form compared to snow or ice. Liquid forms provide greater traction while snow or ice results in less traction and lower travel speeds. |
| Customer perception/satisfaction | Surveys<br>• Measure DOT responsiveness to issues or percentage of customers satisfied with the agency |
| Level of service targets | Percentage of miles meeting an LOS target (e.g., travel time goals, maintenance) |

Chapter 2 provides more comprehensive reviews of snow and ice measures (see Adams et al. 2003; ICF et al. 2019). Texas A&M Transportation Institute publishes its annual *Urban Mobility Report*, which is a nationwide review of congestion-related issues. The 2021 report[38] covered 494 urban areas across the US. Urban areas in Kentucky included Clarksville TN-KY, Cincinnati OH-KY-IN, Louisville-Jefferson County KY-IN, Bowling Green, Elizabethtown-Radcliff, Evansville IN-KY, Huntington WV-KY-OH, Lexington-Fayette, and Owensboro. Mobility performance in these cities is based on the measures listed below. Some are similar to those in Table 4.4.

- Annual hours of delay
- Delay per auto commuter
- Planning Time Index
- Travel Time Index
- Commuter Stress Index
- Annual congestion cost
- Congestion cost per auto commuter
- Annual excess fuel consumed

[38] https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-report-2021.pdf

- Excess fuel consumed per commuter
- Excess CO2 from all vehicles
- Annual truck delay
- Annual truck congestion cost
- Annual excess truck fuel consumed
- Excess CO2 from trucks
- Freeway vehicle miles travelled
- Arterial vehicle miles travelled

Methodologies for calculating each metric can be viewed at:
https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-report-2021-appx-a.pdf.

KYTC Division of Planning also uses several mobility and reliability congestion measures (Table 4.5). Several of these are listed in the report mentioned previously.

**Table 4.5** KYTC Congestion Measures

| Mobility | Definition |
|---|---|
| Volume-to-Capacity Ratio (V/C Ratio) | Volume divided by capacity.<br>• For Level of Service (LOS) calculations, volume is often taken to be the 30th yearly highest. |
| The Level of Service (LOS) | A grade from A to F — with A being free flow and F being very congested — that indicates how well the roadway or intersection is serving its intended traffic. LOS is based on a V/C ratio and has long been used as the primary measure of congestion for planning purposes. |
| Travel Time Index | Ratio of average peak travel time to an off-peak (free-flow) standard<br>• 60 mph is used for freeways<br>• A value of 1.20 means that average peak travel times are 20% longer than off-peak travel times |
| Travel Delay | Amount of extra time spent traveling due to congestion. |
| Percent of Congested Travel | Congested vehicle-miles of travel divided by total vehicle-miles of travel. It is a relative measure of how much travel is affected by congestion. |
| **Reliability** | **Definition** |
| Buffer Index | The extra time (buffer) needed to ensure on-time arrival for most trips.<br>• A value of 40% means that a traveler should budget an 8-minute buffer for a 20-minute average peak trip time to ensure on-time arrival 95% of the time. |
| Planning Time Index | The 95th percentile Travel Time Index. This measure represents the extra time most travelers include when planning peak period trips.<br>• A value of 1.60 means that travelers plan for an additional 60% travel time above the off-peak travel times to ensure on-time arrival 95% of the time. |

Source: KYTC, https://transportation.ky.gov/Congestion-Toolbox/Pages/Congestion-Measures.aspx

Several other approaches are worth considering. Any event that causes a disruption or detour (e.g., landslide, bridge closure) can be viewed in terms of its impact on mobility in the number of vehicles affected and length of detour as well as responsiveness measured by the time to clear the issue. Freight mobility can also be affected by bridge postings. Traffic signals and addressing issues to improve flow might be considered as well.[39] Examining responsiveness in terms of striping time or the time that a roadway condition necessitates repaving to actual repaving.

Some measures can be looked at through price contracts and contractor responsiveness, such as when the contract was issued versus time to fix. Analyzing coordinated traffic signal systems for LOS is also an option. Traffic operations performance measures could take advantage of Automated Traffic Signal Performance Measures[40] as advanced traffic signal technology becomes more widely used across Kentucky.

All DOTs take seriously responsiveness to citizen concerns (e.g., the amount of time that elapses from when an issue is reported to its resolution) For example, North Carolina compiles monthly reports of action requests across maintenance and traffic categories. The agency tracks the number of requests closed on time, those which exceed the time allocated for resolution, and those that are still open (Figure 4.3).

**Statewide**

| Category | Subcategory | AR Count | ARs Closed on Time | ARs Closed Exceeds Time | ARs Open |
|---|---|---|---|---|---|
| Maintenance | Drainage | 1,025 | 723 | 49 | 253 |
| Maintenance | Guardrail Damage | 144 | 113 | 8 | 23 |
| Maintenance | Pothole | 1,324 | 1,050 | 210 | 64 |
| Maintenance | Shoulder Repair | 386 | 296 | 19 | 71 |
| Traffic | Signal Malfunction | 114 | 107 | 3 | 4 |
| Traffic | Signing | 237 | 227 | 1 | 9 |
| **Total** | | 3,230 | 2,516 | 290 | 424 |

**Figure 4.3** North Carolina DOT Citizen Action Request Report June 2021

Much of the roadmap requires deliberation by KYTC stakeholders. A final consideration is the method used to report performance measures. Determining how to communicate performance measures is critical to the success of a performance management program. In most states, dashboards are preferred as they are configured to be simple and easy to interpret and are for public consumption. Graphics employed on dashboards employ universally identifiable symbols (e.g., traffic lights). Dashboards group together measures related to thematically similar areas such as safety, customer service, and infrastructure/asset condition.

[39] See NCHRP Report 812 (Urbanik et al. 2015), Exhibit 3-17, p. 3-22 for more detailed traffic control performance measures.

[40] https://ops.fhwa.dot.gov/publications/fhwahop20002/index.htm

# Chapter 5 Conclusion

Performance measurement and management are integral to many public and private organizations. Measuring outcomes can help guide an organization's focus and ensure its employees have clear goals and targets. KYTC views identifying and implementing performance measures in operations and maintenance as an important goal. The Cabinet's maintenance and operations functions center on responding to customer needs, keeping the traveling public safe, sustaining mobility, and maintaining assets. Previous research has demonstrated the benefits of performance measures. These include improved planning, organizational focus, and function; more informed management decisions; better responsiveness to stakeholders and legislators; and complying with other mandates or requirements. The objective of developing performance measures is to establish a culture of accountability and delivery and better serve the traveling public. Introducing new performance measures can enhance public trust in KYTC's ability to deliver projects and transportation services.

As the Cabinet transitions to a more performance-oriented mindset, it can benefit from understanding how other state DOTs approach performance measures as this provides valuable information on what metrics KYTC could adopt. This project identified performance measurement best practices to highlight performance measures most appropriate for implementation in Kentucky. As KYTC is already working on measures related to asset condition, the report placed more emphasis on metrics related to responsiveness and mobility. Working with the Study Advisory Committee, a list of potential measures was proposed and reviewed. Metrics that received high marks included:

- Response time for complaints and potholes
- Contract response time
- Percentage of time and money spent on routine and emergency maintenance of drainage, guardrail, and cable median barriers
- Response time to repair damaged guardrail and cable median barriers
- Snow and ice expenses and clearance times based on storm severity

The review of other state DOTs catalogued measures that spoke to these areas, including items such as incident clearance times, vehicle miles travelled, travel time reliability, congestion and delay, snow and ice clearance, and customer satisfaction.

Once performance measures are selected, a key consideration is how to communicate measurement data to internal staff and external customers. Many states use dashboards and user-friendly, graphics-intensive formats that are easy to interpret with universally identifiable symbols and ratings. KYTC is beginning to pilot a dashboard focused on asset condition measures and is working to expand that effort by adding responsiveness and mobility measures.

When introducing new performance measures, a key challenge is figuring out they can be operationalized in a way that facilitates improved outcomes. Setting internal targets based on past performance and embracing continuous improvement as a way to meet targets helps employees to see the results of their efforts. For some potential measures challenges will likely remain as many are tied to the reliability of data within OMS. Ensuring this data source is as comprehensive and reliable as possible will aid implementation of maintenance and operations performance measures. After performance measures have been established, the Cabinet will need to examine how funding levels impact performance in different areas. Funding can be allocated based on current performance relative to performance targets. Different investment scenarios can be explored as more data become available. Key considerations include working within available funding levels, forecasting the impact of higher funding levels across the board and targeting funding for specific improvements, and tradeoffs associated with reallocating existing funding.

## References


Adams, Teresa. 2011. *Estimating Cost Per Lane Mile For Routine Highway Operations and Maintenance*. (Project 07-12). Madison, WI: Midwest Regional University Transportation Center.

Adams, Teresa, Mohamad Danijarsa, Tom Martinelli, Gerald Stanuch, and Alan Vonderohe. 2003. Performance Measures for Winter Operations. *Transportation Research Record,* 1824: 87-97.

Adams, Teresa, Ernie Wittwer, John O'Doherty, Marie Venner, and Kyle Schroeckenthaler. 2014. *Guide to Level of Service (LOS) Target Setting for Highway Assets*. (NCHRP Report 14-25). Washington, D.C.: Transportation Research Board.

AASHTO. 2007. *State DOT Performance Management Programs: Select Examples*. https://collaboration.fhwa.dot.gov/dot/fhwa/pm/Lists/aReferences/Attachments/68/TIF%206s%20book%20(2).pdf.

Atkinson, A.A., J.H. Waterhouse, R.B. and Wells. 1997. A stakeholder approach to strategic performance measurement. *Sloan Management Review*, 38(3): 25-37.

Cambridge Systematics. 2000. *A Guidebook for Performance-Based Transportation Planning*. (NCHRP Report 446). Washington, D.C.: Transportation Research Board.

Cambridge Systematics. 2013. *Guide to Incorporating Reliability into Transportation Planning and Programming Processes*. (SHRP 2 Reliability Project L05). Washington, D.C.: Transportation Research Board.

Cambridge Systematics, PB Consult, and Texas Transportation Institute. 2006. *Performance Measures and Targets for Transportation Asset Management*. (NCHRP Report 551). Washington, D.C.: Transportation Research Board.

Cambridge Systematics, Inc., Transmode Consultants, Asil Gezen, and ICF Kaiser Engineers, Inc. 1998, *NCHRP Report 399: Multimodal Corridor and Capacity Analysis Manual*. Washington, DC: Transportation Research Board.

Cambridge Systematics, Applied Research Associates, Arora and Associates, KLS Engineering, PB Consult, and Louis Lambert. 2009. *An Asset-Management Framework for the Interstate Highway System*. (NCHRP Report 632). Washington, D.C.: Transportation Research Board.

Campbell, J.D. 1995. Uptime: Strategies for Excellence in Maintenance Management. Productivity Press, Portland, OR.

Capers, Harry. 2014. *Leading Practices in Large-Scale Outsourcing and Privatization of Maintenance Functions*. (NCHRP Project 20-68A, Scan 11-01). Washington, D.C.: Transportation Research Board.

Crossett, Joe, and Lauren Hines. 2007. *Comparing State DOTs' Construction Project Cost and Schedule Performance- 28 Best Practices from 9 States*. (NCHRP Project 20-24, Task 37A). Washington, D.C.: Transportation Research Board.

Crossett, Joe, Anna Batista, Hyun-A Park, Hugh Louch, and Kim Voros. 2019. *Benchmarking and Comparative Performance Management by Transportation Agencies*. (NCHRP Report 902). Washington, D.C.: Transportation Research Board.

Dadashova, Bahar, Phil Lasley, Pete Koeneman, and Shawn Turner. 2018. Approaches to Presenting External Factors with Operations Performance Measures. *Federal Highways Administration Report*, FHWA-HOP-19-002.

Dalton, D., J. Nestler, J. Nordbo, B. St. Clair, E. Wittwer, and M. Wolfgram. 2001. Transportation Data and Performance Measurement. In *Conference Proceedings 26: Performance Measures to Improve Transportation Systems and Agency Operations*, 75-79.

Denison, Dwight, Christopher Jepsen, Bryan Gibson, Candice Wallace, and Doug Kreis. 2012. *Development of Performance Measures and Revenue Projects for State Highway Transportation Systems*. (KTC-12-19/TA-12-1F). Lexington, KY: Kentucky Transportation Center.

Duncan, G.M., Sibaja Vargas, L.M, Mugabe, K., Zimmerman, K.A. 2018. *Adapting a Culture for Performance Management at the Nevada Department of Transportation*. Carson City, NV: Nevada Department of Transportation.

Dwight, R.A. 1994. Performance indices: do they help with decision-making? *Proceedings of ICOMS-94*, Paper 12, 1-9.

Dye Management Group, Paul D. Thompson Consulting, and Quality Engineering Solutions. 2010. *Development of Levels of Service for the Interstate Highway System*. (NCHRP Report 677). Washington, D.C.: Transportation Research Board.

Federal Highway Administration (FHWA). 2020. *Transportation Performance Management Guidebook*. Washington, D.C.: FHWA. https://www.tpmtools.org/

Gibson, Bryan, Dwight Denison, Candice Wallace, and Doug Kreis. 2015. A Four Step Approach to Assess the Fiscal Performance and Sufficiency of State Road Funds: An Application to Kentucky. *Public Works Management and Policy*, 20(3): 226-247.

Globerson, S. 1985. Issues in developing a performance criteria system for an organization. *International Journal of Production Research,* 23(4): 639-646.

Grant, M., J. D'Ignazio, A. Bond, and A. McKeeman. 2013. *Performance-Based Planning and Programming Guidebook*. Washington, D.C.: Federal Highways Administration.

Harrison, Frances, Hyun-A Park, and Applied Pavement Technologies. 2008. *Comparative Performance Measurement: Pavement Smoothness*. (NCHRP 20-24 (37B)). Washington, D.C.: Transportation Research Board.

Hendren, P., L. Neumann, and S. Pickrell. 2005. Linking Performance-Based Program Development and Delivery. In *Conference Proceedings 66: Performance Measures to Improve Transportation Systems and Agency Operations*, 121-130.

Hyman, W. 2004. *Guide for Customer-Driven Benchmarking of Maintenance Activities*. (NCHRP Report 511). Washington, D.C.: Transportation Research Board.

ICF, Athey Creek Consultants, and Vaisala Inc. 2019. *Performance Measures in Snow and Ice Control Operations*. (NCHRP Report 889). Washington, D.C.: Transportation Research Board.

Jackson, D.L., T.L. Shaw, G. Morgan, D. McLeod, and A.Vandervalk, 2000. *Florida's Reliability Method*. Tallahassee, FL: Florida Department of Transportation.

Kassoff, H. 2001. Implementing Performance Measurement in Transportation Agencies. In Conference Proceedings 26: Performance Measures to Improve Transportation Systems and Agency Operations, 47-58.

Larson, M. 2005. Organizing for Performance Management. In Conference Proceedings 66: Performance Measures to Improve Transportation Systems and Agency Operations, 99-120.

Lea, R. and B. Parker. 1989. The JIT spiral of continuous improvement. *IMDS,* 4: 10-13.

Lomax, T. et al. 2001. *Urban Mobility Report: 2000*. Texas Transportation Institute.

Margiotta, Richard. 2007. *Guide to Effective Freeway Performance Measurement*. (NCHRP Project 3-68). Washington, D.C.: Transportation Research Board.

Markow Michael. 2012. *Performance-Based Highway Maintenance and Operations Management*. (NCHRP Synthesis 426). Washington, D.C.: Transportation Research Board.

McCarthy, Leslie Ann, Seri Park, and Anthony Giancola. 2013. *Practices and Performance Measures for Local Public Agency Federally Funded Highway Projects*. (NCHRP Synthesis 442). Washington, D.C.: Transportation Research Board.

McConnell, Mark, Dale Doughty, Tim Lattner, Laura Mester, Cory Pope, Tony Sullivan, Thomas Van, Lonnie Watkins, and Katie Zimmerman. 2016*. Leading Management Practices in Determining Funding Levels for Maintenance and Preservation*. (NCHRP Project 20-68A, Scan 14-01). Washington, D.C.: Transportation Research Board.

Meyer, M.D. 1995. Alternative Performance Measures for Transportation Planning: Evolution Toward Multimodal Planning. (Report FTA-GA-26-7000-95-1). Atlanta, GA: Georgia Institute of Technology.

National Research Council. 1996. *Measuring and Improving Infrastructure Performance*. Washington, D.C.: National Academy Press.

Meister, Ehren, and William Beatty. 2013. *North Carolina DOT: Development of a Performance Management System*. FHWA Transportation Performance Management Case Study. https://www.fhwa.dot.gov/tpm/resources/docs/nc_casestudy.pdf.

Neely, A., M. Gregory, and K. Platts. 1995. Performance measurement system design: a literature review and research agenda. *International Journal of Operations and Production Management,* 15(4): 80-116.

Neely, A., H. Richards, J. Mills, K. Platts and M. Bourne. 1997. Designing Performance Measures: A Structured Approach. *International Journal of Operations & Production Management*, 17(11): 1131-1152.

Neumann, L. and S. Pickrell. 2001. Use of Performance Measures in Transportation Decision Making. In *Conference Proceedings 26: Performance Measures to Improve Transportation Systems and Agency Operations*, 17-33.

Pickrell, S. and L. Neumann. 2000. "Linking Performance Measures with Decision Making." Presented at the 79th Annual Meeting of the Transportation Research Board Washington, D.C.

Poister, T. 1982. Developing performance indicators for the Pennsylvania Department of Transportation. *Public Productivity Review*, 6:51-77.

Poister, T. 1997. *Performance Measures in State Departments of Transportation*. (NCHRP Synthesis 238). Washington, D.C.: Transportation Research Board.

Poister, T. 2005. Performance Measurement in Transportation: State of the Practice. In Conference Proceedings 66: Performance Measures to Improve Transportation Systems and Agency Operations, 81-98.

Shaw. Terrel. 2003. *Performance Measures of Operational Effectiveness for Highway Segments and Systems*. (NCHRP Synthesis 311). Washington, D.C.: Transportation Research Board.

Smith, J., and T. Adams. 2005. Measures for Highway Maintenance Quality Assurance. *Proceedings of the 2005 Mid-Continent Transportation Research Symposium,* Ames, IA.

Spy Pond Partners and Arora and Associates. 2010. Comparative Analysis of Bridge Conditions. (NCHRP 20-24(37)E). Washington, D.C.: Transportation Research Board.

Spy Pond Partners and Karl Kim. 2009. *Comparative Performance Measurement: Safety*. (NCHRP 20-24(37C)). Washington, D.C.: Transportation Research Board.

Spy Pond Partners, KPMG, and the University of Texas at Austin. 2019. *A Guide to Developing Financial Plans and Performance Measures for Transportation Asset Management*. (NCHRP Research Report 898). Washington, D.C.: Transportation Research Board.

Stivers, M.L., K.L. Smith, T.E. Hoerner, and A.R. Romine. 1999. *Maintenance QA Program Implementation Manual*. (NCHRP Project 422). Washington, D.C.: Transportation Research Board.

Tsang, A., A. Jardine, and H. Kolodny. 1999. Measuring Maintenance Performance: A Holistic Approach. *International Journal of Operations & Productions Management*, 19(7): 691-715.

Turner, S.M., M.E. Best, and D.L. Schrank. 1996. *Measures of Effectiveness for Major Investment Studies*. (Report SWUTC/96/467106-1). College Station, TX: Southwest Region University Transportation Center, Texas Transportation Institute.

Urbanik, Tom, Alison Tanaka, Bailey Lozner, Eric Lindstorm, Kevin Lee, Shaun Quayle, Scott Beaird, Shing Tsoi, Paul Ryus, Doug Gettman, Srinivasa Sunkari, Kevin Balke, and Darcy Bullock. 2015. *Signal Timing Manual- Second Edition*. (NCHRP Report 812). Washington, D.C.: Transportation Research Board.

Van Dyke, C., J. Walton, and J. Ballinger. 2016. Synthesis of Kentucky's Traveler Information Systems. *Kentucky Transportation Center Research Report*, KTC-16-17/SPR16-56-2-1F.

Yurek, R., N. Albright, J. Brandenburg, M. Haubrich, L. Hendrix, D. Hillis, L. Rodriguez, and K. Zimmerman. 2012. *Best Practices in Performance Measurement for Highway Maintenance and Preservation*. (NCHRP Scan 10-03). Washington, D.C.: Transportation Research Board.

## Appendix A Guidelines for Asset Management Performance Measures

(Cambridge Systematics et al. (2006) p. 53-54)

1. Performance measures should be selected to cover established goals and objectives.
2. Performance measures should be consistent with the criteria used to make resource allocation decisions.
3. Predictive models or methods for relating investment levels to future performance should be available for each performance measure selected.
4. Performance measures should have appropriate sensitivity to show impacts of decisions about resource allocation across program areas, geographic areas, and subnetworks.
5. Performance measures used for initial resource allocation and program development should also be used to assist in determining program adjustments.
6. Performance measures used to guide project selection and resource allocation at the program level should include cost-effectiveness and benefit/cost measures, which (where feasible and appropriate) incorporate user costs or benefits.
7. Performance measures used to evaluate investment tradeoffs should reflect life-cycle benefits and costs, not just immediate impacts.
8. Performance monitoring needs to include tracking of asset condition over time at a sufficient level of detail and rigor to support development of performance curves. This is needed to provide the basis for credible prediction tools that analyze investments versus performance.
9. Performance measures should describe not only physical asset condition but also how assets are serving their intended functions with respect to comfort, convenience, safety, and service.
10. Monitoring of outcome- and output-oriented performance measures needs to be accompanied by tracking of actual activity costs in order to provide the basis for credible prediction tools that analyze investments versus performance.
11. Performance measures should be selected with consideration of the cost of data collection and available methods for maximizing efficiencies.
12. Performance measures are needed that can serve as the basis for target setting with respect to what various programs will accomplish. Because actual monitored performance may depend on factors other than agency actions, the target setting and monitoring processes must account for the fact that many performance measures reflect not only results of actions taken by an agency, but external factors as well (e.g., traffic volumes and environmental conditions).
13. Performance measures should be useful for signaling when changes to strategies and priorities are warranted—in long-range plan updates and in development of capital, maintenance, and operations program budgets.
14. Performance measures reflecting asset condition and performance should be used consistently across different functional units and at different levels of the organization. This implies that performance measures should be amenable to “roll-up” and “drill-down” capabilities to allow them to be viewed at systemwide, district, corridor, subarea, subnetwork, or location-specific levels. This roll-up capability may include the need to calculate summary statistics (e.g., “percent poor lane-miles”) from more detailed, location-specific condition measurements.
15. To the maximum extent possible, performance measures should be understandable and meaningful to political leaders and the general public.

## Appendix B Key Performance Indicators Survey Results

| State DOT | Provide a list of Key Performance Indicators | Which division or unit tracks the Key Performance Indicators? | Where does the information reported exist? | How are the Key Performance Indicators determined and are there other metrics for tracking project/program delivery? | What mechanisms are used to track? |
|---|---|---|---|---|---|
| Indiana | KPI #1: State Controlled Roads in Fair or Better Condition - annually KPI #2: Well-Maintained Bridges - monthly KPI #3: Net Change in Construction Costs - monthly KPI #4: Construction Contracts Completed On Time (30 days in arrears) - monthly KPI #6: JTRP Conversion Rate - annually | KPI one through four are reported using OBIEE and transferred to the executive scorecard that is delivered monthly to the leadership team and are available on the INDOT intranet site. KPI # two and three are sent to the governor's office. The metrics fall under three separate executives. I have been here two years in May and the metrics have not changed. The responsibility may have due to organization changes, but the metrics have not. | No. There is no golden source. We have a data warehouse, and is fed by numerous source systems, but we have a lot of garbage in / garbage out. In addition to OBIEE, we have an Enterprise Metrics system where metrics are entered manually. How they are created, I am not sure, very likely manually Yes. | Our Program Delivery dashboard in OBIEE is the most used and most changed "dashboard." | No. We have a PM department within MIS, but my experience with them is No Most of it is fed from the source systems to the data warehouse and processed in OBIEE No. I would have to say most units have their own reporting, and it goes further to the district level. I am sure it is all manual |

| | | | | | |
|---|---|---|---|---|---|
| Nevada | They are distributed amongst the major divisions. Administration - 5 Operation - 6 Planning - 1 Engineering - 3 | Every Division tracks their KPI but are all coordinated by the Performance Analysis Division The metrics are determine by the Director's office in coordination with the Division heads of the various units | In the Performance Analysis Division and published on the department's website | It depends on the division and the metric | Pavement management system, Bridge management system, Maintenance management system, spreadsheets, |
| Massachusetts | Please see MassDOT's annual performance website, Tracker: https://www.massdottracker.com/ | KPIS are used in MassDOT's rail and transit unit, aeronautics, highway, registry of motor vehicles, along with the MBTA. For the annual performance report, OPMI coordinates the collection of data for each KPI and then reports on the performance in the annual report. | There is not a central or standard database. Each division uses their own system. The annual performance report, and MassDOT's capital investment plan brings this information together in one place. | Dashboards (PowerBI) are used by the Highway Division to track project delivery. I'm sure other divisions use other things, but I'm not sure of what they all are. | OPMI uses Asana and Airtable for projet management. I'm not sure what other divisions within MassDOT use. |
| Kentucky | On-Time On-Budget | State Highway Engineer's Office | N/A | N/A | N/A |

| | | | | | |
|---|---|---|---|---|---|
| Wyoming | We have 48 programs that have a BSC. Each program is broken out to have their own KPIs. If you would like more information, we can get this to you but the amount of data to be included in this question would be too much to answer. | Our team, Program Performance, helps each program to develop and implement KPIs. Each program is responsible for updating KPI information and updates. As the KPIs are directly related to our Strategic Plan, we are in the process of collecting data for a report out so all program can see what each other are working on. | Each Unit is responsible for tracking their KPI. We are looking at a more centralized approach (dashboard, PM system) but have not chosen one yet. | Scorecards are how we currently track the KPIs. | Right now we use spreadsheets with each BSC. Each program is responsible for their own tracking and getting us the information. |
| Wisconsin | See Above | Project information related to the KPI for the CEs is provided by the Region Environmental Coordinators from each of our 5 Regions. The environmental document tracking information for all CEs is assembled by one person in the EPDS central office unit. The liaisons in the EPDS unit to each Region review the random | The environmental document data for the CE KPI is kept on the EPDS SharePoint site. The results of the KPI are put into a Word document each year and transmitted to FHWA. The Section 106 MOA KPI information is also a Word report which I believe is uploaded to the WisDOT Division SharePoint site. | The answers to this question are included in the previous answers. | SharePoint is the only tool used to track and upload data used for the CE KPI. |

| | | | | | |
|---|---|---|---|---|---|
| | | documents for compliance. The resulting review is compiled by one person and EPDS and transmitted to FHWA for review. The KPI for the Section 106 MOA WisDOT Performance Measure is compiled by the EPDS Cultural Resources Team (2 people). This information is provided to the Department as a Performance Measure on a triennial basis. | | | |
| Washington | The subject index (link below) is a rough idea of the KPIs we cover in the Gray Notebook. We also have an Excel document that I can email over which closer to what you are looking for, but it's an older document that we will update this year. https://www.wsdot.wa.gov/publications/fulltext/graynotebook/gray-notebook-subject-index.pdf | Bridges, pavement, Washington State Ferries, Incident Response, Environmental Services Office, Rail and Freight, Active Transportation, Safety, HR, Capital Projects, Aviation, Capital Facilities, Commercial Vehicle Services, Highway Maintenance, Electric Vehicles | a) No standard form exists, and tracking methods, etc. vary greatly, but the Gray Notebook serves as a clearing house for vetting and publishing WSDOT's KPIs b) Other than the Gray Notebook, no c) Hybrid | a) We use dashboards b) We also use program and project KPIs | a) No b) Unknown c) No forms d) Differs for each program |

| | | | | | |
|---|---|---|---|---|---|
| | | Division, a) Yes and no b) Yes and no c) Yes and no | | | |
| Washington | None established. | None | Agency performance metrics (if recorded) reside in the Gray Notebook (GNB) produced, developed, maintained by the Performance Management Office. (I'm not speaking to the Research Office projects.) | Still developing. | We do have RPMD (Research Performance software) developed by a TPF years ago. This software is outdated. |
| Utah | Unfortunately I do not have a list of KPI or metrics per unit. I am working on hiring a Performance Manager to begin the task of organizing and evaluating the measures. At one count last summer, we had nearly 370 separate measures posted to the Tactical Measures section of the Strategic Direction website. http://www.udot.utah.gov/strategic-direction/ | The Measures are currently measured and tracked individually. This will change in the future with our Performance Manager. I anticipate that we will undertake ongoing reviews of the metrics and make cross communication of the measures more prevalent. | It is currently available from our strategic direction website. http://www.udot.utah.gov/strategic-direction/ | The Tactical Measures section of the Strategic Direction website hosts the metrics. | We currently use Microsoft Power BI for visualizing and analyzing the data. |

| | | | | | |
|---|---|---|---|---|---|
| Idaho | See ITD's website: https://apps.itd.idaho.gov/Apps/Dashboard/ Five year fatality rate per 100 million vehicle miles - Highways/Office of Highway Safety Percent of time highways are clear of snow/ice during winter storms - Highways/Mobility Services Percent of pavement in good or fair condition - Highways/Asset Management Percent of bridge in good condition - Highways/Bridge Percent of highway project designs completed on or ahead of time - Highways/ITIP PMO Final construction cost as a percent of contract award - Highways/Construction/Materials Construction cost at award as a percent of budget - Highways/Contracting Services Administration and Planning expenditures - Division of Administration Days to process vehicle titles - Division of Motor Vehicles DMV transactions processed on the internet - Division of Motor Vehicles | The Individual units responsible for tracking and reporting results are identified in response to question 7. ITD's Office of Communication then posts the results on to the ITD website. | Various computer systems and databases. At the current time much of the tracking and reporting is manual, unless the individual section has found a way to automate. We have no central automation for tracking and reporting performance measures. | Performance measures were developed several years ago and we've kept them the same. We report these to the ITD external website. | Ours is a manual process at this point. |
| Minnesota | Project Management and Tech Support Percent of number of project lettings per quarter measured against targets for an optimal letting schedule. Number of projects with negative float (various combinations of float and time are used). Project delivery costs as a percent of total construction costs to track trends. | Project delivery KPIs are determined and measured by the central office project support section and shared with all the other central functional offices and the districts. All other KPIs are developed by the business unit for use within | Project delivery data is kept in an agency-wide project scheduling application database. Measures associated with business plans are kept in spreadsheet templates that are able to be | KPIs are developed by the functional/technical areas as a way to measure and improve their performance. In some case there are scoreboards created. | Project Management Tool - Oracle's Primavera P6 |

| | | | | | |
|---|---|---|---|---|---|
| | | the business unit. As business planning matures, there will be more sharing of those measures with leadership and the financial office. | | | |
| Rhode Island | For the Office of Project Management: 1. Percentage of On-Time Project Performance by federal fiscal year class 2. Percentage of On-Budget Project Performance by federal fiscal year class. | As noted above, other business units within the Department also collect, track and report KPI's. These KPI's are determined by each responsible unit in collaboration with the staff of the RIDOT Office of Performance Management (OPM). KPI's are calculated and communicated by the responsible Unit to a central repository system (shared Excel spreadsheet) maintained by OPM staff. | The Office of Project Management maintains a Project Tracking System (database) which is used to capture the necessary information required to track the unit's KPIs. This system is linked to the department's Financial Management System (FMS) to obtain each active project's current expenses including approved change orders. An external Excel spreadsheet is used to manually calculate the quarterly on-time and on-budget KPI's. As for the KPI's tracked by other RIDOT business units, each unit is responsible for calculating the KPI and data entering their | The department also publishes the RIDOT Monthly Performance Management Metrics poster which is posted throughout the main RIDOT building. It presents the KPI's and also graphically illustrates the monthly trendline for the following additional metrics: • Traffic fatalities • Percent of bridge deck area by condition compared to targeted condition • Pothole calls made to the Transportation Management Center | The Project Tracking System (PTS) is an in-house Access database that collects the project level on-time and on-budget metrics for each project. An Excel spreadsheet is used to calculate the summary program's KPI's on a quarterly basis. The Department's accounting system, Financial Management System, does not report project KPI's, rather it is linked to the PTS to supply the current project budget information. Examples of the RIDOT's Project Tracking System data entry forms, which capture each active project's Schedule and Project Budget information, are available upon request. |

| | | | | | |
|---|---|---|---|---|---|
| | | | respective KPI manually into a central shared and password protected Excel spreadsheet. | | (See Attachment B) Project level information is used to calculate the summarized quarterly KPI's for the Office of Project Management. |
| Tennessee | HQ: - Project readiness for project letting schedule - Contract readiness and compliance - Administration of Department policy and procedures - Audit of region office Compliance of policy and procedures Region: - Compliance of Department policy and procedures as evaluated by audits - Readiness of projects for letting By number of larges projects individual is responsible for coordination (Grade & Drain, Widening, New location, etc.) By number of small projects individual is responsible for coordination (Intersection, bridge replacement, etc.) By number of maintenance projects individual is responsible for coordination (safety, resurfacing, bridge repair, etc.) | a) Each division is responsible for performance accounting to the Assistant Chief Engineer of Design over the ROW Division. Each division develop performance measures in consultation with the Assistant Chief Engineer. The performance measures are tracked for each staff individual and complied by Region, and then by Division in a compilation to the | a) Each region report is submitted on a standard excel spreadsheet, in part obtained by reports generated by the Division application IRIS (Integrated ROW Information System) b) Region staff use IRIS to perform coordination and therefore the data necessary to submit performance is available in the application reports. c) Hybrid in that the Region supervisor has the ability to query IRS and to made necessary adjustments | HQ tracks projects that are delayed past the delivery date, and for what reasons it is delayed to verify the performance measure report | a) IRIS b) outside the system c) simple excel spreadsheet d) manual standard format excel spreadsheet. |

| | | | | | |
|---|---|---|---|---|---|
| | | Assistant Chief Engineer for the calendar year. b) HQ develops consistent measures statewide c) Each Region staff performance is reported and compiled by HQ for each region, and for Division statewide. | to the performance report for staff changes, work assignments, etc. | | |