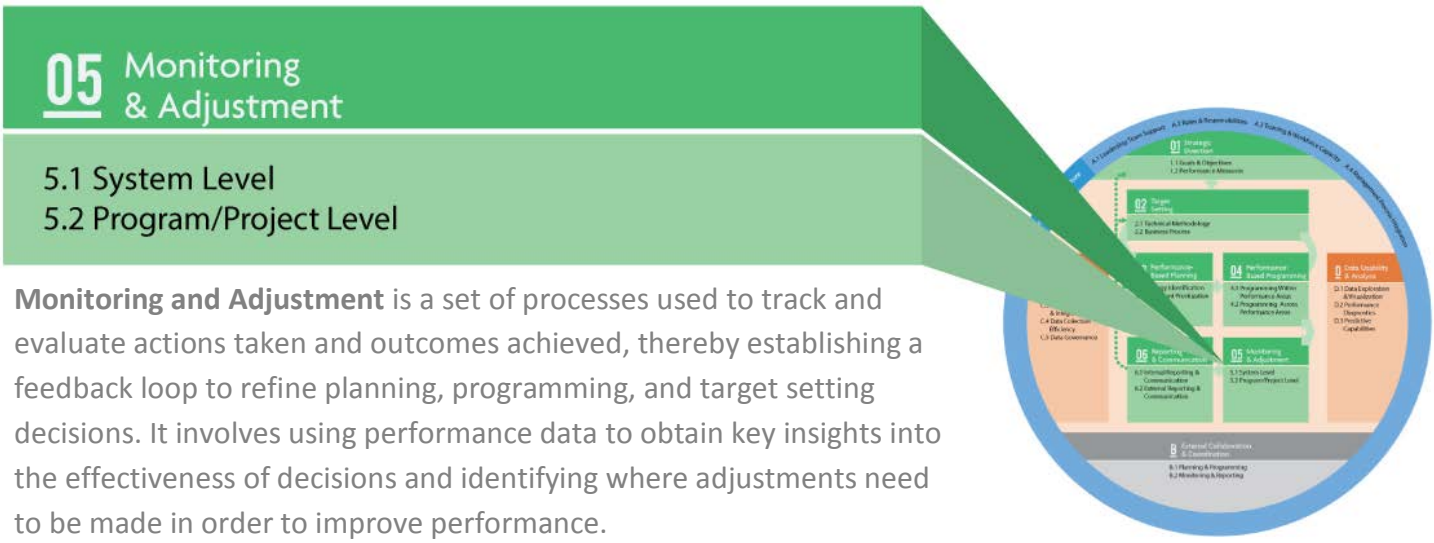
U.S. Department of Transportation
Federal Highway Administration

COMPONENT 5

MONITORING & ADJUSTMENT

This chapter provides assistance to transportation agencies with the "Monitoring and Adjustment" component of Transportation Performance Management (TPM). It discusses where monitoring and adjustment occurs within the TPM Framework, describes how it interrelates with the other nine components, presents definitions for associated terminology, provides links to regulatory resources, and includes an action plan exercise. Key implementation steps are the focus of the chapter. Guidebook users should take the TPM Capability Maturity Self-Assessment (located in the TPM Toolbox at www.tpmtools.org) as a starting point for enhancing TPM activities. It is important to note that federal regulations for monitoring and adjustment may differ from what is included in this chapter.



Monitoring and Adjustment is a set of processes used to track and evaluate actions taken and outcomes achieved, thereby establishing a feedback loop to refine planning, programming, and target setting decisions. It involves using performance data to obtain key insights into the effectiveness of decisions and identifying where adjustments need to be made in order to improve performance.

INTRODUCTION

Transportation agencies have been monitoring performance results for some time. However, it is what agencies do with the monitoring information that ends up distinguishing transportation performance management from performance measurement. Under a simple performance measurement framework, an agency sets a strategic direction, defines measures and tracks results. There are many benefits associated with these three elements including the establishment of the agency's purpose, improved communication of performance trends, and enhanced accountability. To move into the realm of transportation performance management, agencies must actively use information gained from monitoring performance data to obtain key insights into the effectiveness of decisions and identifying where adjustments need to be made. The combination of monitoring and adjustment processes is the "bread and butter" of TPM, establishing a critical feedback loop between performance results and future planning, programming and target setting decisions.

Establishment of robust monitoring and adjustment practices benefits an agency by:

- Providing early warning of emerging project delivery and system performance issues;
- Discovering new insights into causal factors contributing to performance outcomes;
- Highlighting needed adjustments to project and programs based on actual results;
- Identifying data gaps that need to be closed;
- Providing a reality check on performance targets; and
- Enhancing the understanding of which strategies are effective and why.

> "Embrace the power of "why"—Focusing on the why clearly communicates that performance management intends to understand the results and identify improvements, not to punish."
>
> Source: "Moving from Reactive to Strategic Decisions Making." TR News 293 July-August 2014

Through monitoring and adjustment practices, an agency can answer, "Are we getting the results we anticipated"? as well as "If not, why not"? The ongoing review of observed results helps agencies identify, diagnose, and act upon program delivery issues. This process also identifies where data gaps exist and highlights where additional information would be beneficial. As an agency's understanding of the relationship between actions taken and performance results improves, so will an agency's ability to make necessary mid-stream adjustments, select future projects and programs to achieve desired outcomes, and explain performance results to stakeholders. Given that TPM practices evolve over time, monitoring and adjustment processes provide valuable material upon which future iterations can build.

The processes implemented under the monitoring and adjustment component focus on the outputs and outcomes of specific transportation projects and programs as well as the performance of the overall transportation system. Outputs refer to the quantity of activity delivered through a project or program: the miles of pavement repaved, the number of bridges rehabilitated, the number of new buses purchased, etc. Outputs are important to track in order to evaluate whether the project or program is on scope, on time and on budget. Did the agency deliver the level of activity that was promised? Outcomes refer to the results of interest to users of the transportation system: travel time reliability, fatality rates, etc. An effective monitoring and adjustment process must look at both output and outcomes to create a strong connection between investment decisions and results.

Through this TPM component, an agency examines what actions are accomplishing the desired impact(s) on performance results (Figure 5-1) and considers why they have been effective or not. Progress toward targets is gauged as well as whether those targets are reasonable. Linking decisions to results reveals potential adjustments needed to deliver the projects, as well as further refinement of the selection of strategies. As a result, the Monitoring and Adjustment component has a clear, direct linkage to Target Setting (Component 02), Performance-Based Planning (Component 03) and Performance-Based Programming (Component 04). By closely analyzing the relationship between actions and results, this component strengthens the connection between what agency staff does on a daily basis and the ultimate strategic goals an agency is trying to achieve (Strategic Direction, Component 01). The information gathered through monitoring and adjustment processes creates a foundation for the external and internal products developed under Reporting and Communication (Component 06), agency management functions (Organization and Culture, Component A), and may assist in the fulfillment of local, state, and Federal regulatory requirements.

Activity refers to an action taken to implement a strategy (e.g., purchase additional maintenance vehicles).

Output refers to "level of activity" (e.g., number of miles repaved).

Outcomes demonstrate the "effectiveness" of a particular activity (e.g., travel time reliability).

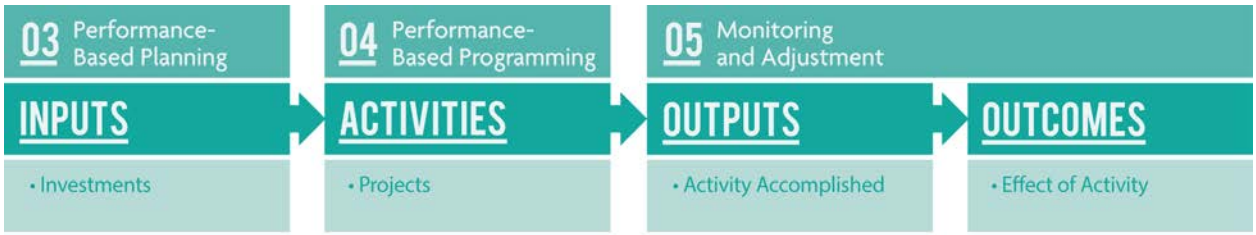
Sources: NCHRP Report 446, Guidebook for Performance-Based Planning; FHWA, Performance Based Planning and Programming Guidebook

Since the monitoring and adjustment component helps agencies understand and react to the pursuit of established targets and strategic goals, the more established an agency's strategic direction and target processes are, the easier it will be to implement monitoring and adjustment processes. In some agencies, monitoring and adjustment may take place naturally, as part of an established transportation performance management process, whereas in others, the steps must be put in place purposefully, in order to emphasize the importance of the relationship between decisions and results. This relationship is cemented through well-defined monitoring and adjustment processes.

A well-crafted monitoring framework allows an agency to determine whether progress is taking place in advance of deadlines for required reporting and, if necessary, enable adjustments to programming so that significant progress is more likely to be attained. An agency may also need to use monitoring information to justify the setting of a new target. Ongoing monitoring and adjustment enables an agency to track the activities it is undertaking and the outputs produced (direct results of an activity, such as miles of pavement resurfaced), and the impact on outcomes (broader effects such as improved mobility or access to activity centers). Reporting and Communication (Component 06) describes steps an agency can take to effectively communicate this documentation to internal and external audiences.

Figure 5-1: Relationship Between Inputs and Outcomes

Source: Federal Highway Administration

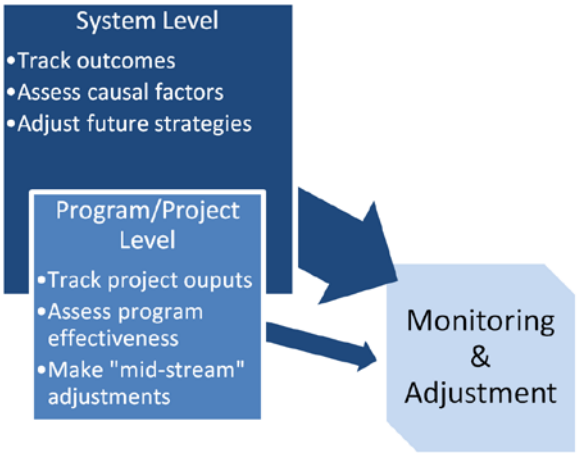


SUBCOMPONENTS AND IMPLEMENTATION STEPS

The definition for Monitoring and Adjustment is: a set of processes used to track and evaluate actions taken and outcomes achieved, thereby establishing a feedback loop to refine planning, programming, and target setting decisions. It involves using performance data to obtain key insights into the effectiveness of decisions and identifying where adjustments need to be made in order to improve performance. The component is comprised of two subcomponents, with the Program/Project Level Monitoring and Adjustment subcomponent nested within the System Level Monitoring and Adjustment subcomponent:

Figure 5-2: Subcomponents for Monitoring and Adjustment

Source: Federal Highway Administration



- **System Level Monitoring and Adjustment:** Establishment of a well-defined performance-monitoring process to understand past and current performance. The analysis of performance results leads to an improved understanding of causal factors and increases an agency's ability to act on new insights. This enhanced understanding of why performance results occurred feeds future planning and programming decisions. Within this system outcome viewpoint, Program/Project Level Monitoring and Adjustment clarifies the contribution of specific programs and projects on achieving goals, objectives and targets.
- **Program/Project Level Monitoring and Adjustment:** Establishment of a process for tracking program and project outputs, and their effects on performance outcomes. This process provides early warning of potential inability to achieve performance targets. Insights are used to make project or program "mid-stream" adjustments and guide future programming decisions. This subcomponent provides a before/after project-level view and is nested within the System Level Monitoring and Adjustment subcomponent.

System Level Monitoring and Adjustment

System level monitoring and adjustment focuses on the linkage between resource allocation decisions and the achievement of strategic goals and objectives. A well-defined monitoring process helps agencies diagnose information on factors that affect outcomes such as available funding and external economic, environmental and social trends. Refining agency monitoring processes, the collection of additional data, and improved analysis capabilities provides new insights into causal factors contributing to performance. A key characteristic of this subcomponent is the application of performance monitoring information to identify where adjustments need to be made. These insights in turn can be used in future planning and programming decisions. System level monitoring typically has a wider scope and a long-range time horizon. An understanding of the relationship between actions and results can take years to assess—as is the case within the safety performance area.

> "The purpose of PBPP is to ensure that results of previous investments and policies inform future decision-making so that transportation agencies can better understand approaches that work best given constraints and conditions."
>
> Source: FHWA, Performance Based Planning and Programming Guidebook

Program/Project Level Monitoring and Adjustment

The program/project level monitoring and adjustment subcomponent assesses specific programs and projects. This includes summary statistics such as dollars expended or outputs delivered. In addition, analyses are conducted to

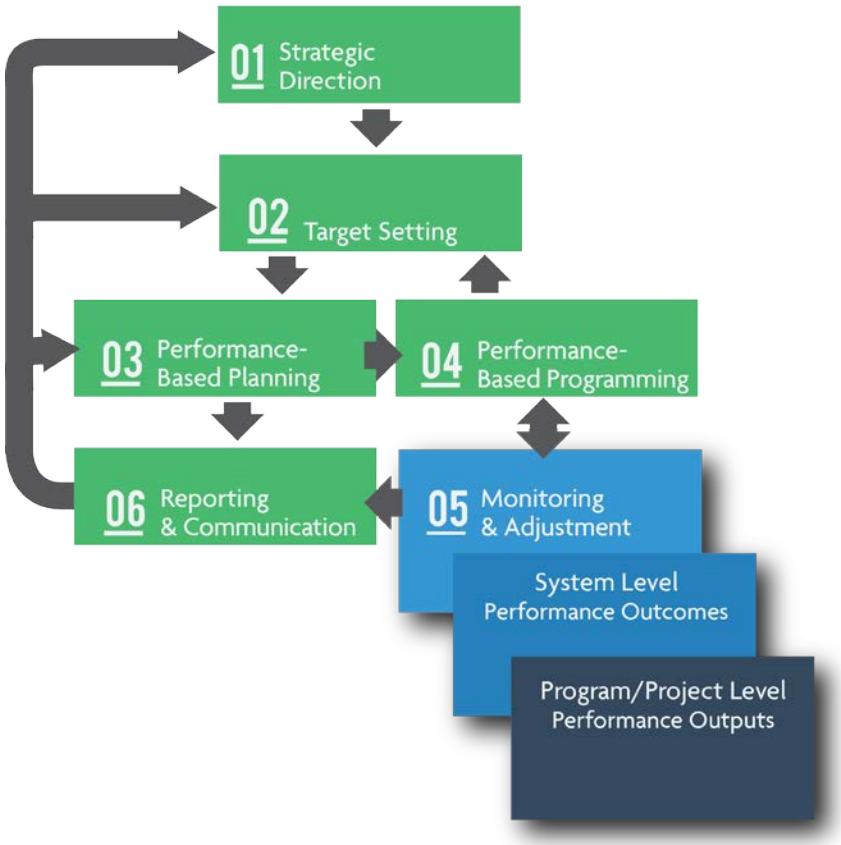
gain a better understanding of the effectiveness of a project or program on desired performance targets. The program/project level monitoring process typically has a narrow focus (e.g., speed improvements resulting from a traffic flow improvement project) and has a shorter timeframe than system monitoring and adjustment efforts. A well-defined program monitoring process gives an agency a better understanding of risk factors that could impact its ability to deliver the program and improves early warning of emerging issues. In addition, before/after studies give agencies new insights into causal factors that may be strong drivers of performance outcomes. With this additional diagnostic information, agencies are able to make project or program adjustments "mid-stream" to address delivery issues, improve the effectiveness of projects and better guide future decisions. In short, program/project level monitoring gives agencies the information necessary to understand, diagnose and act upon delivery issues. Over time, the regular process of monitoring the effect of implemented programs and projects will guide future planning, programming, and target setting decisions.

Outline of Implementation Steps

The importance of linking actions and results is the reason that monitoring and adjustment takes the form of a distinct component within the TPM framework. Although the "monitoring" lens through which the programs and project or system performance varies by scope and time horizon, these processes help agencies understand what progress is being made toward established targets and strategic goals. Together, program/project level and system level monitoring and adjustments establish a critical feedback loop between performance results and future planning, programming, and target setting decisions (see Figure 5-3). However, it is the active use of monitoring information to identify and implement adjustments that makes this component the cornerstone of TPM.

Figure 5-3: TPM Components Flowchart

Source: Federal Highway Administration



Both Monitoring and Adjustment subcomponents are intended to provide actionable information to an agency, with one nested within, and informing, the other. The steps necessary to implement program/project level and system level monitoring and adjustment processes are in Table 5-1. How these steps are applied within the two subcomponents is further explored in this chapter.

Table 5-1: Monitoring and Adjustment Implementation Steps

Source: Federal Highway Administration

System Level and Program/Project Level
1. Determine monitoring framework
2. Regularly assess monitoring results
3. Use monitoring information to make adjustments
4. Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions
5. Document the process

CLARIFYING TERMINOLOGY

Table 5-2 provides definitions for the target setting terms used in this Guidebook. A full list of common TPM terminology and definitions is included in Appendix C: Glossary.

Table 5-2: Monitoring and Adjustments: Defining Common TPM Terminology

Source: Federal Highway Administration

Common Terms	Definition	Example
Activity	Refers to actions taken by transportation agencies, such as projects, related to strategy implementation.	Paving key locations, adding new guardrail, rehabilitating a bridge, purchasing new buses.
Adjustment	The alteration of programming, planning, targets, measures, and goals resulting from analysis of information collected.	The restriping of a construction project to address an observed increase in traffic incidents.
Goal	A broad statement of a desired end condition or outcome; a unique piece of the agency's vision.	A safe transportation system.
Monitoring	The identification and diagnosis of performance systems and programs.	Freeway and Arterial System of Transportation (FAST), a real-time traffic condition dashboard that enables detailed analysis on request.
Objective	A specific, measurable statement that supports achievement of a goal.	Reduce the number of motor vehicle fatalities.
Outcome	Results or impacts of a particular activity that are of most interest to system users. Focus of subcomponent 5.1 System Level Monitoring and Adjustment.	Transit travel time reliability, fatality rate, percent of assets within useful life.

Common Terms	Definition	Example
Output	Quantity of activity delivered through a project or program. Focus of subcomponent 5.2 Program/Project Level Monitoring and Adjustment.	Miles of pavement repaved, miles of new guardrail put into place, the number of bridges rehabilitated, the number of new buses purchased.
Performance Measure	Performances measures are based on a metric that is used to track progress toward goals, objectives, and achievement of established targets. They should be manageable, sustainable, and based on collaboration with partners. Measures provide an effective basis for evaluating strategies for performance improvement.	Transit passenger trips per revenue hour.
Performance Period	An established timeframe for monitoring results and collecting data and information for performance reporting.	A calendar year.
Reporting	Summary documentation of performance trends for either internal or external audiences.	WSDOT Gray Notebook.
Sub-Measure	A detailed quantifiable indicator uncovered during monitoring that provides additional insights into internal and external processes.	Preventive maintenance compliance—a driver of overall asset performance.
Transportation Performance Management	A strategic approach that uses system information to make investment and policy decisions to achieve performance goals.	Determining what results are to be pursued and using information from past performance levels and forecasted conditions to guide investments.

RELATIONSHIP TO TPM COMPONENTS

The ten TPM components are interconnected and often interdependent. However, the monitoring and adjustment component is particularly notable given that it serves as the critical feedback loop within the TPM Framework. As the means to answering the questions, "Are we getting the results we anticipated"? as well as "If not, why not"? this component helps agencies determine progress toward performance targets (Component 02) and in turn, strategic goals (Component 01). Through an increased understanding of the effect of specific projects and programs on outcomes, the monitoring and adjustment component uncovers information to be used in future planning (Component 03) and programming (Component 04) decisions. This monitoring and adjustment component helps agency staff link their day-to-day activities to results and ultimately agency goals (Organization and Culture, Component A). The external and internal reporting and communication products (Component 06) are based on the information gathered during monitoring and adjustment. Finally, the cornerstone of all TPM components is quality data. By establishing well-defined monitoring and adjustment processes, the quality of the data agencies use will naturally improve and enable identification of data gaps that need to be addressed.

Linkages between monitoring and adjustment and the other nine TPM components are depicted in Table 5-3.

Table 5-3: Monitoring and Adjustment Relationship to TPM Components

Source: Federal Highway Administration

Component	Summary Definition	Relationship to Monitoring and Adjustment
01. Strategic Direction	The establishment of an agency's focus through well-defined goals/objectives and a set of aligned performance measures.	The information uncovered during the monitoring and adjustment phase helps agencies assess progress toward the goals and objectives defined under the strategic direction.
02. Target Setting	The use of baseline data, information on possible strategies, resource constraints, and forecasting tools to collaboratively establish targets.	As agencies better understand the effectiveness of projects and programs through monitoring and adjustment, the feasibility of attaining targets will be clearer, resulting in potential target adjustments.
03. Performance-Based Planning	Use of a strategic direction to drive development and documentation of agency strategies and priorities in the long-range transportation plan and other plans.	Reviewing performance trends through monitoring and adjustment provides key insights into the actual versus predicted effectiveness of alternative strategies (before/after analysis) with respect to agency goals. Monitoring establishes a key feedback loop to future planning decisions, including necessary strategy adjustments and the identification of new strategies.
04. Performance-Based Programming	Allocation of resources to projects to achieve strategic goals, objectives and performance targets. Clear linkages established between investments made and their expected performance outputs and outcomes.	Improved knowledge about influencing factors and the relationship between investments and performance results explored through monitoring processes will improve the assumptions used for future programming decisions.
06. Reporting and Communication	Products, techniques, and processes to communicate performance information to different audiences for maximum impact.	The monitoring and adjustment process provides a foundation for external and internal reporting and communication products regarding performance. This component also provides the explanation for why target and program adjustments are necessary.
A. TPM Organization and Culture	Institutionalization of a TPM culture within the organization, as evidenced by leadership support, employee buy-in, and embedded organizational structures and processes that support TPM.	Monitoring and adjustment strengthens the connection between what agency staff do on a daily basis and the ultimate strategic goals and agency is trying to achieve. This component provides a forum for leadership to better understand performance results, provide support, and assign roles and responsibilities as needed.
B. External Collaboration and Coordination	Established processes to collaborate and coordinate with agency partners and stakeholders on planning/ visioning, target setting, programming, data sharing, and reporting.	Examining the relationship between programs and performance results will create a pool of data and analysis that can be shared with external partners to clarify and explain adjustments made.

Component	Summary Definition	Relationship to Monitoring and Adjustment
C. Data Management	Established processes to ensure data quality and accessibility, and to maximize efficiency of data acquisition and integration for TPM.	Monitoring and adjustment processes are dependent on the availability of timely, accurate and authoritative data.
D. Data Usability and Analysis	Existence of useful and valuable data sets and analysis capabilities, provided in usable, convenient forms to support TPM.	Through regular performance monitoring, the quality of the data agencies use will improve, and data gaps that need to be closed will be identified (e.g., "sub-measures" that provide new insights into factors influencing performance results).

REGULATORY RESOURCES

This Guidebook is intended to assist agencies with implementing transportation performance management in a general sense and not to provide guidance on compliance and fulfillment of Federal regulations. However, it is important to consider legislative requirements and regulations when using the Guidebook. In many cases, use of this Guidebook will bring an agency in alignment with Federal requirements; however, the following sources should be considered the authority on such requirements:

Federal Highway Administration

- Transportation Performance Management: http://www.fhwa.dot.gov/tpm/links_fhwa.cfm
- Fact Sheets on Fixing America's Surface Transportation (FAST) Act: https://www.fhwa.dot.gov/fastact/factsheets/
- Fact Sheets on Moving Ahead for Progress in the 21st Century (MAP-21): https://www.fhwa.dot.gov/map21/factsheets/
- Resources on MAP-21 Rulemaking: https://www.fhwa.dot.gov/tpm/rule.cfm

Federal Transit Administration

- Fact Sheets on FAST Act: https://www.transit.dot.gov/funding/grants/fta-program-fact-sheets-under-fast-act
- Resources on MAP-21: https://www.transit.dot.gov/regulations-and-guidance/legislation/map-21/map-21-program-fact-sheets

IMPLEMENTATION STEPS

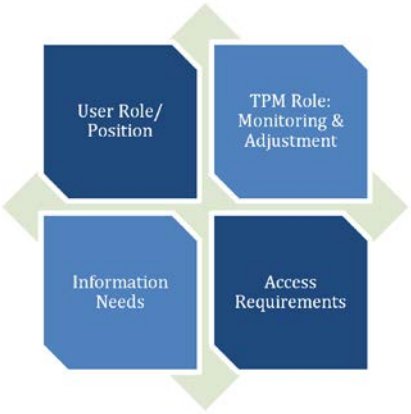
5.1 SYSTEM LEVEL

The system level monitoring and adjustment subcomponent focuses on the linkage between resource allocation decisions and the achievement of strategic goals and objectives. A well-defined monitoring process helps agencies diagnose information on factors that affect outcomes such as available funding and external economic, environmental and social trends. Refining agency monitoring processes, collecting additional data, and improved analysis capabilities provides new insights into causal factors contributing to performance. A key characteristic of this subcomponent is the application of performance monitoring information to identify where adjustments need to be made. These insights can be used in future planning and programming decisions. System level monitoring typically has a wider scope and a long-range time horizon. Understanding the relationship between actions and results can, in some instances, take years to assess. The following section outlines steps agencies can follow to establish system level monitoring and adjustment processes.

1. Determine monitoring framework
2. Regularly assess monitoring results
3. Use monitoring information to make adjustments
4. Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions
5. Document the process

STEP 5.1.1	System Level: Determine monitoring framework
Description	

Figure 5-4: Strategic Monitoring
Source: Federal Highway Administration



The first step toward establishing a monitoring framework is to define what metrics are to be tracked, the frequency, and data sources. In addition, it is important to identify who needs to see the monitoring information—for what purpose and in what form? Monitoring efforts should take place regularly, with data collection and management ongoing, as discussed further in Components C and D. Developing a strategy for efficient monitoring and adjustment involves balancing the need for frequent information updates within the constraints of resource efficiency. Setting monitoring frequency should be done such that information is produced often enough to capture change. It should not be done so frequently that it creates extra unnecessary work, and not so infrequently that it misses early warning signs. Striking the right reporting frequency balance will take agencies time to figure out and will vary based on what is being monitored. Having the ability to vary monitoring frequency greatly enhances an agency's capacity not only to respond to internal and external requests, but also to identify necessary planning and programming adjustments.

The typical system level monitoring runs on a long-range timeframe; it can be monthly up to a

STEP 5.1.1	System Level: Determine monitoring framework
	multi-year basis. This is because gaining an understanding of the linkage between resource allocation decisions and system performance results can take several years. **Items to keep in mind as the monitoring framework is being developed:** • **Include at a minimum the performance measures used to assess progress toward strategic agency goals (Component 01)**. All elements of a transportation performance management approach need to connect back to the agency's strategic direction and performance targets. • **Coordinate with other agency business.** There will be opportunities to combine efforts with annual reports, plan updates, and other ongoing business processes. Efficiencies can be achieved by aligning with legislative or budgetary milestones. • **Expand monitoring capabilities through data partnerships.** The sharing of data internally across agency departments and with external partners can greatly enhance an agency's monitoring and adjustment capabilities. • **Identify data gaps.** Once the monitoring metrics have been determined, determine the suitability of the available data and existing gaps (see Data Usability and Analysis, Component D). As the monitoring process matures, data needs will likely need to expand to improve the understanding of the causes behind progress or lack thereof. • **Clarify how monitoring needs vary by user.** Identifying the range of monitoring-information users (e.g., performance analyst versus senior agency manager) will help determine the monitoring framework. (See Data Management, Component C). • **Establish close ties** to reporting and communications efforts (Component 06).
Example	Within **Utah DOT's** long-range transportation plan (LRTP), the agency assesses the attainment of each strategic goal. For example, under the goal of system preservation, the areas of pavement condition, bridge condition, and maintenance each have their own targets toward which plans and programs are strategized. UDOT has structured its monitoring framework such that an annual update, Strategic Direction 2015, requires monitoring checkpoints on performance measures and targets developed in the four-year LRP.[1] Below, the Maintenance Division at UDOT reports its targets as well as yearly progress toward them (Figure 5-5). Figure 5-6 shows a view of UDOT's Click 'n Fix Dashboard that staff uses to track daily maintenance requests. Staff can see the number of reported issues on a day to day basis, and the interface also allows monitoring via maps and reports regarding completed or incomplete requests. The key here is the linkage back to the agency's strategic goals and performance targets. UDOT integrates annual monitoring efforts into its LRTP process in order to assess progress on a systemic level, and then also monitors on a programmatic level to assess progress toward performance targets within specific program areas, such as system preservation. The monitoring framework is set up so that there are yearly updates within performance areas, as well as the ability to check in still more frequently via a project-tracking dashboard.

[1] Utah Department of Transportation. (2015). Strategic Direction 2015. Taylorsville, UT. https://www.udot.utah.gov/main/uconowner.gf?n=19974707633468335

STEP 5.1.1	System Level: Determine monitoring framework

Figure 5-5: MMQA Select Key Measurements: Projects Completed v. Targets

Source: Strategic Direction 2015[2]

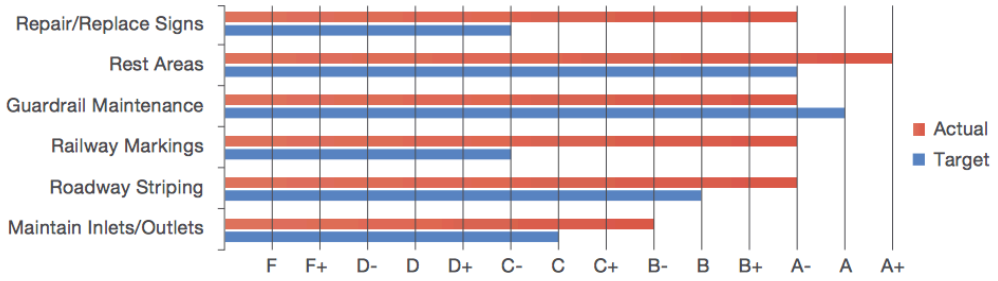
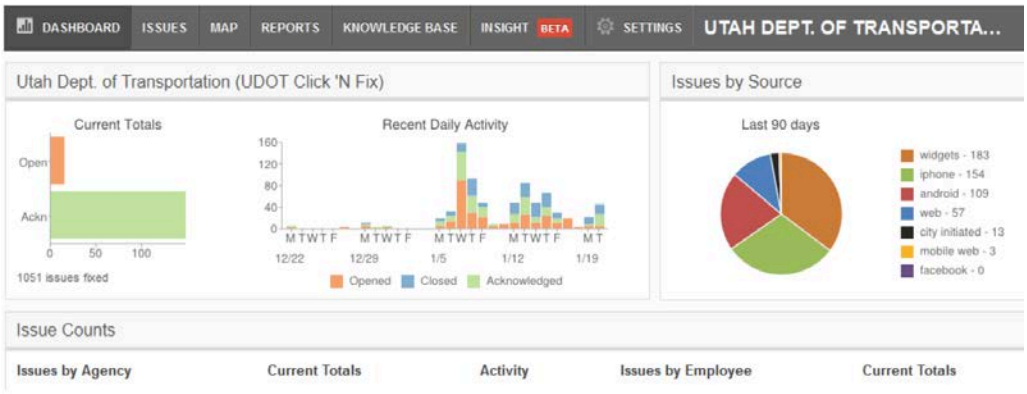


Figure 5-6: UDOT Click 'n Fix Dashboard

Source: Strategic Direction 2015[3]



Linkages to Other TPM Components	Component 01: Strategic Direction	(See TPM Framework)
	Component 02: Target Setting	
	Component 04: Performance-Based Programming	
	Component 06: Reporting and Communication	
	Component C: Data Management	
	Component D: Data Usability and Analysis	

STEP 5.1.2	System Level: Regularly assess monitoring results
Description	This step entails instituting a well-defined performance-monitoring process to understand past and current performance. At a minimum, an agency should review the performance trends for each measure developed under the Strategic Direction (Component 01). During this step, it is important to return to the internal and external factors at play that may have an impact on

[2] Utah Department of Transportation. (2015). Strategic Direction 2015. Taylorsville, UT. https://www.udot.utah.gov/main/uconowner.gf?n=19974707633468335

[3] Utah Department of Transportation. (2015). Strategic Direction 2015. Taylorsville, UT. https://www.udot.utah.gov/main/uconowner.gf?n=19974707633468335

STEP 5.1.2	System Level: Regularly assess monitoring results

progress toward a goal. Factors might include ongoing public input, a shift in priorities, or a change in any of the many external or internal factors that might potentially impact the agency's work (see Table 5-4 below). If ongoing monitoring reveals that an agency is falling short of a performance target, this might indicate that the target was not realistic, the strategies were not effective, or one factor or a combination of factors threw performance results off course. In this step, conduct performance diagnostics to understand system performance trends.

Table 5-4: Review of Potential Influencing Factors

Source: Federal Highway Administration

Internal	External
Funding	Economy
Staffing constraints	Weather
Data availability and quality	Politics/legislative requirements
Leadership	Population growth
Capital project commitments	Demographic shifts
Planned operational activities	Vehicle characteristics
Cultural barriers	Zones of disadvantaged populations
Agency priorities	Vehicle characteristics
Agency jurisdiction	Modal shares
Senior management directives	Gas prices
Policy directives (e.g., zero fatalities)	Land use characteristics
Cross performance area tradeoffs	Driver behavior
Collaboration across agency	Traffic

Below is a set of questions that can be used to start the performance diagnosis. While the specific questions will depend on the specific performance area, the following types of questions will generally be applicable:

- What is the current level of performance?
  - How does it vary across different types of related measures (e.g., pavement roughness, rutting, and cracking)?
  - How does it vary across different transportation system subsets (e.g., based on district, jurisdiction, functional class, ownership, corridor, etc.)?
  - How does it vary by class of traveler (e.g., mode, vehicle type, trip type, age category, etc.)?
  - How does it vary by season, time of day, or day of the week?
- Is observed performance representative of "typical" conditions or is it related to unusual events or circumstances (e.g., storm events or holidays)?
- How does our performance compare to others?
  - How does it compare to the national average?

STEP 5.1.2	System Level: Regularly assess monitoring results
	○ How does it compare to peer agencies? • How does the current level of performance compare to past trends? ○ Are things stable, improving or getting worse? ○ Is the current performance part of a regular occurring cycle? • What factors have contributed to the current performance? ○ What factors can we influence (e.g., hazardous curves, bottlenecks, pavement mix types, etc.)? ○ How do changes in performance relate to general socio-economic or travel trends (e.g., economic downturn, aging population, lower fuel prices contributing to increase in driving)? • How effective have our past actions to improve performance been (e.g., safety improvements, asset preventive maintenance programs, incident response improvement, etc.)?
Example	The **Regional Transportation Commission (RTC)** is the metropolitan planning organization (MPO) for Southern Nevada, including the Las Vegas Valley, and is tasked with identifying programs and projects to improve air quality, provide mobility options, and enhance transportation efficiency and safety. In monitoring how effective RTC strategies are in making progress toward the region's nine goals, a key external factor RTC must consider is the fact that Southern Nevada continues to grow rapidly in terms of economy and population. This increases demands on the transportation system as a whole, while also compounding the complexities of funding it. While the recession impacted funding levels, it only slowed rather than stopped area growth, leading to an increased mismatch between available transportation financing and system needs.[4] As a result of the potential impacts from these external factors, RTC has utilized a model to estimate regional economic and population growth developed by the University of Nevada Las Vegas's Center for Business and Economic Research. RTC coordinated the use of this model by local jurisdictions in the region, so that RTC can better predict travel demand, congestion increases, and air quality impacts[5] and hence better understand the outcomes of their strategies and how the system is serving customers. By monitoring the demands on the system as well as its outcomes, RTC is better able to assess the financial needs for meeting those demands. As a result of the uncertainties caused by the rate of growth in the area and accompanying financial model complexity, RTC includes many "unfunded needs" projects in its program to reflect and track unmet needs over the course of the plan period. RTC recognizes how important external influences are in understanding the region's ability to make progress toward its goals and objectives.

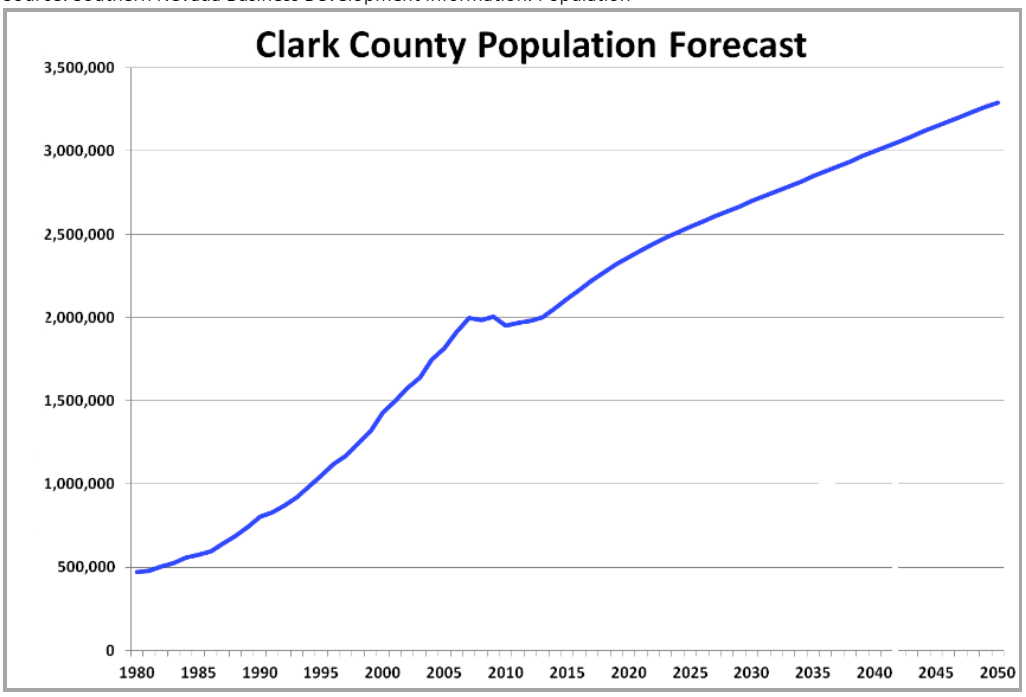
[4] Regional Transportation Commission of Southern Nevada. (2012). Regional Transportation Plan, 2013-2035, p. 36. http://www.rtcsnv.com/wp-content/uploads/2012/10/Final_RTP-2013-35-Redetermination-0214131.pdf

[5] Regional Transportation Commission of Southern Nevada. (2012). Regional Transportation Plan, 2013-2035, p. 41. http://www.rtcsnv.com/wp-content/uploads/2012/10/Final_RTP-2013-35-Redetermination-0214131.pdf

STEP 5.1.2	System Level: Regularly assess monitoring results

Figure 5-7: Clark County Population Growth Projection through 2050

Source: Southern Nevada Business Development Information: Population[6]



Linkages to Other TPM Components	Component 01: Strategic Direction (See TPM Framework) Component 02: Target Setting Component C: Data Management Component D: Data Usability and Analysis

STEP 5.1.3	System Level: Use monitoring information to make adjustments

Description

With a better understanding of past and current performance, agencies can isolate what causal factors they can influence and act on these new insights.

Items to keep in mind as monitoring information is used to consider adjustments:

- **Passage of time.** Has enough time passed to gain a true picture of progress? The trajectory of progress is not always a straight-line movement; more data points may be necessary to fully understand the trend. Often, momentum can build or can be impacted by external factors over the measurement timeframe.
- **Constraints.** Agencies may be hindered from making program and project adjustments by TIP and RTP amendment cycles, budget development timeline, legislative requirements (e.g., delivery of conformity model runs).
- **Anomalies.** Consider whether there were special circumstances driving the performance results. A single event or factor can have a sizable impact, so something

[6] University of Nevada Las Vegas, Center for Business and Economic Research. (2016). Clark County Population Forecast. Las Vegas, NV. http://cber.unlv.edu/charts/Clark%20County%20Population%20Forecast.pdf

STEP 5.1.3	System Level: Use monitoring information to make adjustments

atypical occurring, such as a natural disaster or unexpected funding change, can lead to erroneous conclusions if not adequately understood.

- **Reliability of predicted performance improvements from adjustment.** Before implementing any adjustments, agencies should analyze future performance. In general, predictive capabilities should allow agencies to compare the "do nothing" scenario versus the potential impacts of adjustment (see Data Usability and Analysis, Component D).
- **"Sub-measures" that provide new insights into causal factors contributing to performance.** A sub-measure is a detailed quantifiable indicator uncovered during monitoring that provides additional insights into internal and external processes (e.g., preventive maintenance compliance—a driver of overall asset performance).

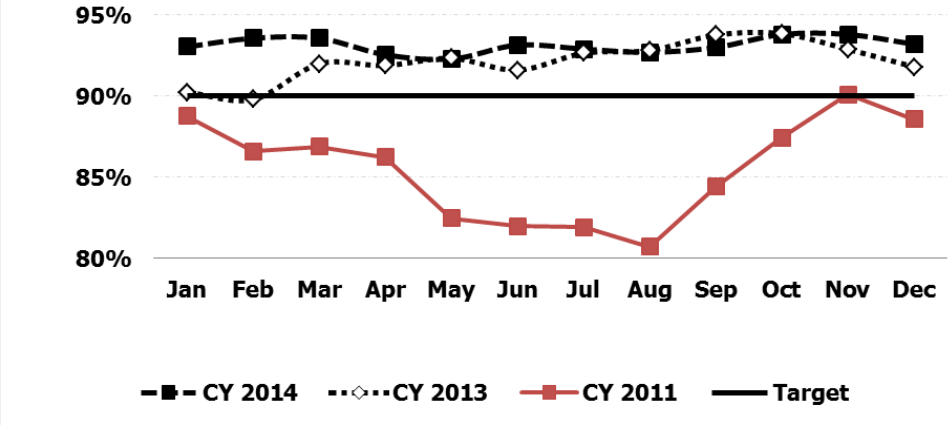
After these considerations, determine whether course correction is necessary. A communications strategy should be in place to ensure that stakeholders are informed and up to date on monitoring results and their consequences. If changes are made, be sure that any new measures, goals, or targets are calibrated to the preceding ones to ensure continuity and comprehensible documentation.

Example

At the Washington Metropolitan Area Transit Authority (WMATA), escalator availability is a top priority of the agency's customers. In 2011, the agency was suffering from very low escalator availability (Figure 5-8):

Figure 5-8: Escalator System Availability

Source: Adapted from Vital Signs Report: 2014 Annual Results[7]



Agency staff conducted a range of performance diagnostics to try and uncover the root cause of the dismal performance results. The analysis discovered a preventive maintenance compliance rate of 44%. Quickly this new sub-measure was regularly tracked and discussed during executive management meetings. WMATA put increased emphasis on preventive maintenance, conducting more proactive inspections to identify issues before problems occurred, concentrating on mechanic training, expanding quality control inspections before escalators were returned to service, and realigning maintenance staff into geographic regions designed to improve response times. The result was a notable increase in preventive maintenance compliance and improved escalator availability.

[7] Washington Metropolitan Area Transit Authority. (2014). Vital Signs Report: A Scorecard of Metro's Key Performance Indicators 2014 Annual Results. Washington, DC. http://www.wmata.com/about_metro/docs/Vital_Signs_Report_Q4_2014.pdf

STEP 5.1.3	System Level: Use monitoring information to make adjustments
Linkages to Other TPM Components	Component 01: Strategic Direction (See TPM Framework) Component 02: Target Setting Component A: Organization and Culture Component C: Data Management Component D: Data Usability and Analysis

STEP 5.1.4	System Level: Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions
Description	This step creates the critical feedback loop between performance results and future planning, programming and target setting decisions. To create an effective feedback loop, the monitoring information and the effect of adjustments need to be integrated into future strategic direction development (Component 01) and the setting of performance targets (Component 02). Through an increased understanding of the linkage between resource allocation decisions and results, the monitoring and adjustment component uncovers information to be used in future planning (Component 03) and programming (Component 04) decisions. This component also helps agency staff link their day-to-day activities to results and ultimately agency goals (Organization and Culture, Component A). The external and internal reporting and communication products (Component 06) need to be based on the information gathered during monitoring and adjustment.  **Figure 5-9: Feedback Loop** Source: Federal Highway Administration
Example	A serious snow-related congestion event on February 9, 2014 on Colorado Interstate 70 turned a two-hour drive on I-70 into an eight-to 10-hour journey.[8] This event became a catalyst for the **Colorado Department of Transportation (CDOT)** to reexamine its maintenance and operations practices on this busy corridor. CDOT also engaged in an extensive monitoring of the corridor's mobility and safety results. **Because of this, the agency determined that the current level of performance on the corridor was not acceptable and made the following adjustments:** • **Infrastructure.** Colorado DOT widened the east and westbound Twin Tunnels, the first improvements along the corridor in 40 years. • **Operations.** Colorado DOT invested $8 million to implement strategies such as additional plow drivers, snowplow escorts on the Eisenhower Tunnel approach, and ramp traffic metering at key locations. • **Public Education.** Colorado DOT launched a public education campaign, Change Your Peak Drive, and worked with partners and other stakeholders to educate the public

[8] Whaley, Monte, "CDOT Tackling I-70 Mountain Corridor," The Denver Post, April 6, 2014. http://www.denverpost.com/news/ci_25504609/cdot-tackling-i-70-mountain-corridor

STEP 5.1.4	System Level: Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions

on driver behavior issues such as having good tires, driving safely around plows, traveling during off-peak times, and finding information such as broadcasted radio updates, and carpooling.[9]

The Division of Highway Maintenance was also given an elevated leadership role in coordinating capital and annual maintenance. It received additional staff support to accomplish this, with Directors of Operations assigned to each corridor, and maintenance crews and equipment pledged from other areas of the state for the winter. Additionally, in order to make the improvements real to the public, assist in monitoring efforts, and measure outcomes of this shift, Maintenance and Operations leadership began developing milestones and metrics around new objectives related to improved mobility on I-70 and I-25. This was assisted by departmental efforts to improve data gathering efforts and provide more accurate time measurements for closures, delays, and causes of delay.[10]

Aligned with this systemic shift, the improvements to I-70 are specifically called out in the January 9, 2015 *Action Plan* for implementation and are further discussed below.[11] In addition, a key mobility goal within the Strategic Actions developed for the Statewide Plan specifically calls for the development of Regional Operations Implementation Plans, Corridor Operations Plans, and tools to focus resources and solve issues at the regional and corridor levels.[12]

In June 2015, Colorado DOT revealed the performance improvements that had occurred as a result of these efforts over the course of Winter 2015, demonstrated by before and after mobility and safety measurements on I-70. The agency found that injuries and fatal crashes were reduced by 35%, and weather-related crashes were reduced by 46%. Unplanned closure time decreased by 16%; the number of hours of eastbound delay greater than 75 minutes was decreased by 26%.[13] Further efforts will continue to be developed, such as training for corridor first responders, defining performance measures for traffic incident clearance, and establishing a schedule of routine incident debriefings and performance assessments.[14] COtrip, an online interface offering live camera monitoring, incident monitoring, and real time road conditions was launched to assist in communicating conditions to users as well as aid monitoring efforts.

[9] Colorado Department of Transportation, "CDOT Improvements to I-70, Paired with Driver Awareness, Reduced Crashes and Delays This Winter," June 29, 2015. https://www.codot.gov/news/2015-news-releases/06-2015/cdot-improvements-to-i-70-paired-with-driver-awareness-reduced-crashes-and-delays-this-winter

[10] Scott Richrath, Email to Trish Hendren, May 18, 2015.

[11] http://coloradotransportationmatters.com/wp-content/uploads/2015/03/CDOT_Action_Plan.pdf

[12] Colorado Department of Transportation. Strategic Actions for the Statewide Plan. http://coloradotransportationmatters.com/wp-content/uploads/2015/03/CDOT_ES_TopStrategicActions_3-16-15.pdf.

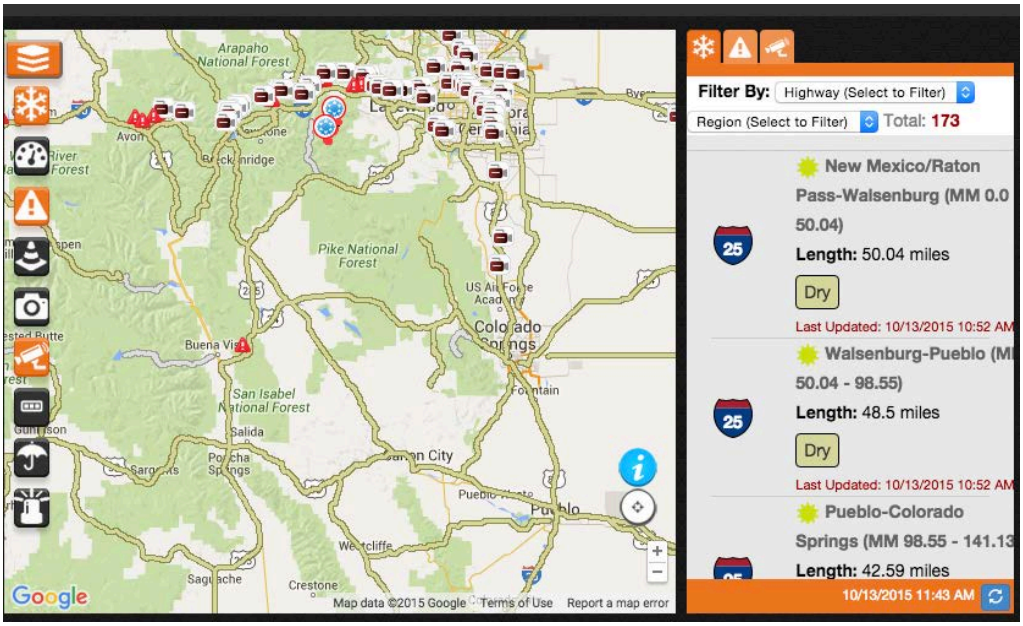
[13] https://www.codot.gov/news/2015-news-releases/06-2015/cdot-improvements-to-i-70-paired-with-driver-awareness-reduced-crashes-and-delays-this-winter

[14] https://www.codot.gov/travel/winter-driving/I-70WestTrafficMgmt.html

STEP 5.1.4	System Level: Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions

Figure 5-10: CO Trip User Interface

Source: Colorado Department of Transportation[15]



Colorado DOT's actions on I-70 illustrates actions taken to adjust targets, prioritize projects, and allocate resources after the February 2014 serious weather and congestion event caused delays that impacted mobility performance to an unacceptable degree. This has been documented and incorporated into priorities for Colorado DOT's upcoming update to its Statewide Transportation Plan. Moving forward, monitoring of performance on these corridors will reveal any change in outcomes due to this shift in operations and resources, or may reveal further opportunities for improvement.

Linkages to Other TPM Components

Component 01: Strategic Direction (See TPM Framework)

Component 02: Target Setting

Component 03: Performance-Based Planning

Component 04: Performance-Based Programming

Component 06: Reporting and Communication

Component A: Organization and Culture

Component C: Data Management

Component D: Data Usability and Analysis

[15] Colorado Department of Transportation - COtrip Road Map. June 2, 2016. http://cotrip.org/map.htm#/roadWork

STEP 5.1.5	System Level: Document the process
Description	Document the process, including progress, outputs, outcomes, and any strategic adjustments and the reasoning behind these. This includes documentation for the purposes of internal operations, ensuring that the monitoring and adjustment process is replicable in future iterations of plans and throughout multiple planning efforts. It also includes steps toward gathering and organizing data (see Components C and D) in order to ensure that external reporting (Component 06) can be carried out in a sustainable and impactful way.
Examples	Several examples are offered here to illustrate how strategic level monitoring and adjustment processes and any subsequent changes to goals and targets are documented. **Program Delivery Monitoring at Southwestern Pennsylvania Commission** The Southwestern Pennsylvania Commission (SPC) offers a large amount of documentation regarding each individual program area's monitoring and adjustment processes. As an example, within its congestion management program, SPC implements strategies under divisions of demand management, modal options, operational improvements, and capacity improvements. SPC documents all of the performance measurements and associated monitoring calculations directly on its website. [16] Gathered here are all the associated studies, reports, and other tools SPC uses to highlight, analyze, and evaluate the effectiveness of various congestion management strategies implemented.[17] As an example within this program, HOV lanes are listed as one strategy implemented to help reach congestion goals in the SPC region. SPC documents the reasoning behind the strategy and its relationship to the agency's congestion targets. Before and after analysis is completed using results from monitoring traffic delay, and detailed information is included as to how calculations were reached and compared. This ensures that the same monitoring process can be reproduced indefinitely, allowing ongoing understanding of how investment in HOV lanes has enabled SPC to progress toward its congestion reduction target and its mobility goals.[18] **Program Delivery Monitoring at Missouri DOT** In the last decade, faced with increasing costs and decreasing revenue streams, the Missouri Department of Transportation (MoDOT) revisited its pavement management program. Based on financial constraints, the agency decided to focus its efforts on improving major highways, rather than spreading resources out over minor roads as well, as had been done according to a past formula. MoDOT established a target that would benefit the most users per dollar spent and relaxed its target for overall pavement condition that included minor roads. As a result of this adjustment, fewer resources were allocated to the preservation of minor roads, and the percentage of minor roads in good condition decreased from 71% to 60% from 2005 to 2009.[19] At the same time, however, MoDOT was able to respond to customers' desires for

[16] Southwestern Pennsylvania Commission, "Congestion Management Process: Performance Measures," http://www.spcregion.org/trans_cong_pm.shtml

[17] Southwestern Pennsylvania Commission, "Congestion Management Process: Strategy Implementation and Monitoring Effectiveness," http://www.spcregion.org/trans_cong_mon.shtml

[18] http://www.spcregion.org/pdf/cmpdoc/Operational%20Improvements/ParkwayNorth_HOVAnalysis_April2008.pdf

[19] Missouri Department of Transportation. (October 2014). *Tracker: Measures of Departmental Performance,* "Keep Roads and Bridges in Good Condition," 2a.

STEP 5.1.5	System Level: Document the process
	smoother roads by significantly improving the condition of major routes, from 47% in 2004 to 85% in 2007. Currently over 89% of major highways are in good condition, but MoDOT recognized that this condition level would be difficult to maintain without additional resources.[20] MoDOT used its Tracker performance measurement tool to document this adjustment to its performance targets and measures, and to monitor and report the results, which are released quarterly. Documenting the decision to focus more resources on major routes rather than on the system overall was key to MoDOT's ability to measure progress moving forward and also to ensure stakeholders understood the adjustment. MoDOT measures its progress not only with typical performance measures, but also through regular customer satisfaction surveys and focus groups to determine whether improvement projects are making the anticipated progress toward a satisfactory user experience—therefore communicating this strategy back to users using monitoring data was critical.[21] This documentation shows how the programs and projects implemented as MoDOT's pavement strategies are intended to impact progress toward performance targets.
Linkages to Other TPM Components	Component 01: Strategic Direction (See TPM Framework) Component 02: Target Setting Component 03: Performance-Based Planning Component 04: Performance-Based Programming Component 06: Reporting and Communication Component C: Data Management Component D: Data Usability and Analysis

[20] Missouri Department of Transportation. (October 2014). *Tracker: Measures of Departmental Performance,* "Keep Roads and Bridges in Good Condition," 2a.
[21] National Cooperative Highway Research Program. (2010). *Transportation Performance Management: Insight from Practitioners*. NCHRP Report 660, 35. Washington, DC. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_660.pdf

5.2 PROGRAM/PROJECT LEVEL

The purpose of this subcomponent is to establish a process for tracking program and project outputs, and the effect of programs and projects on performance outcomes. This process provides early warning of potential inability to achieve performance targets. Insights are used to make project or program "mid-stream" adjustments and guide future programming decisions. The following section outlines steps agencies can follow to establish program/project level monitoring and adjustment processes. While the step names are identical, descriptions of monitoring activities within each step vary.

1. Determine monitoring framework
2. Regularly assess monitoring results
3. Use monitoring information to make adjustments
4. Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions
5. Document the process

> "A performance-based approach shifts the focus off of 'can we deliver the project on budget' to 'are we doing the right set of projects.' Monitoring and adjustment processes help us understand project results – information that is key to picking an effective set of projects year after year to maximize taxpayer investment into the system by focusing on projects that truly drive a better and safer outcome."
>
> - Greg Slater, MD State Highway Administration

STEP 5.2.1	Program/Project Level: Determine monitoring framework
Description	

Figure 5-11: Strategic Monitoring
Source: Federal Highway Administration

The first step toward establishing a monitoring framework is to define what metrics are to be tracked, the frequency, and data sources. In addition, it is important it identify who needs to see the monitoring information—for what purpose and in what form. Monitoring efforts should take place regularly, with data collection and management ongoing, as discussed further in Components C and D. Developing a strategy for efficient monitoring and adjustment involves balancing the need for frequent information updates within the constraints of resource efficiency. Monitoring frequency should produce information often enough to capture change, yet not so frequently that it creates extra unnecessary work, and not so infrequently that it misses early warning signs. Striking the right reporting frequency balance will take time to figure out and will vary based on what is being monitored. Having the ability to vary monitoring frequency will greatly enhance an agency's capacity not only to respond to internal and external requests, but also to identify necessary planning and programming adjustments.

The typical program/project level monitoring ranges from 'up-to-the-minute' to a yearly basis. To assess the effectiveness of programs and projects, annual updates should occur at a minimum, with regular internal check-ins a must for understanding if projects are being delivered on time and within scope. However, gaining an understanding of the effect strategies are having on performance results may take longer.

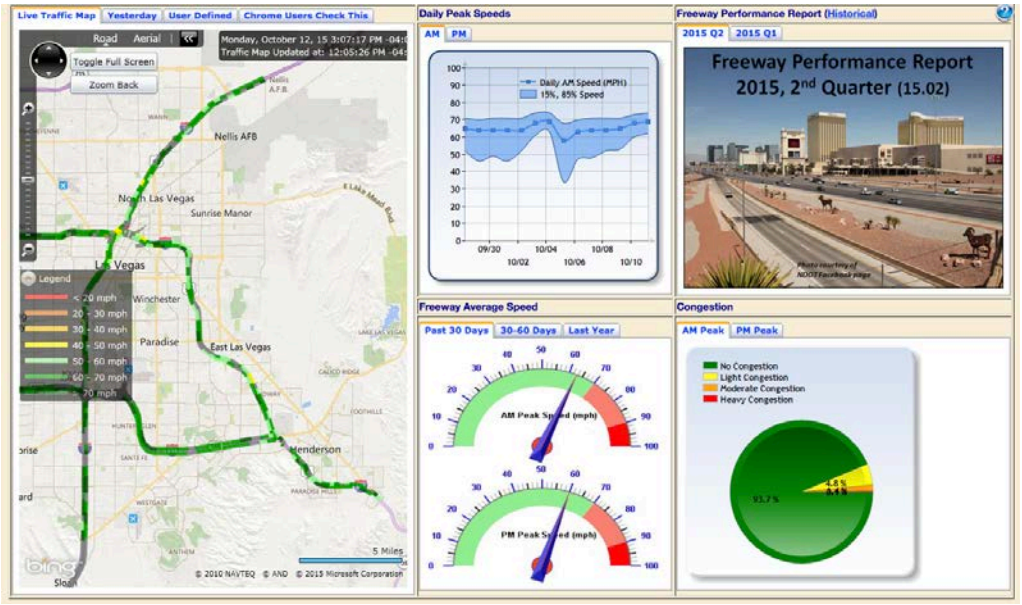
STEP 5.2.1	Program/Project Level: Determine monitoring framework
	Items to keep in mind as the monitoring framework is being developed: • **Link metrics used in monitoring to strategic direction.** All elements of a transportation performance management approach need to connect back to the agency's strategic direction and performance targets. • **Coordinate with other agency business.** There will be opportunities to combine efforts with annual reports, plan updates, and other ongoing business processes. Efficiencies can be achieved by aligning with legislative or budgetary milestones. • **Expand monitoring capabilities through data partnerships.** The sharing of data internally across agency departments and with external partners can greatly enhance an agency's monitoring and adjustment capabilities. • **Identify data gaps.** Once the monitoring metrics have been determined, determine the suitability of the available data and existing gaps (see Data Usability and Analysis, Component D). As the monitoring process matures, data needs will likely need to expand to improve the understanding of the causes behind progress or lack thereof. • **Clarify how monitoring needs vary by user.** Identifying the range of monitoring information users (e.g., performance analyst versus senior agency manager) will help determine the monitoring framework (see Data Management, Component C).
Example	The FAST system (**Freeway and Arterial System of Transportation**) is a comprehensive monitoring effort that develops, implements, and maintains an Intelligent Transportation System (ITS) administered by the Regional Transportation Commission (RTC) in conjunction with the Nevada Department of Transportation (NDOT). Nevada's ITS includes coordinated traffic monitoring cameras, signal timing, and a portfolio of projects such as ramp metering and informative signage aimed at reducing congestion and improving user experience along major corridors throughout the region. Using FAST to monitor Southern Nevada's major corridors, RTC can devise mobility improvements without relying solely on system expansion, and can better prioritize the most impactful programs and projects based on performance measures.[22] FAST helps RTC define and track progress toward meeting performance targets, which ultimately defines specific project needs and impacts such as maintenance, critical missing links and capacity needs.[23] FAST is an award-winning real-time monitoring dashboard that enables detailed analysis on request.[24] The dashboard displays feeds from cameras to track congestion along the corridors. This interface is monitored by RTC staff to develop quarterly reports on congestion events and understand historic patterns. The system archives thousands of screen shots of traffic camera feeds every few seconds. This means that RTC staff can perform analysis immediately to understand the impacts of a particular event. A screenshot of the dashboard is shown below. A live map is available on the left hand side; average speeds analysis for the past 30 days is displayed in the middle; and the latest quarterly reports and a peak congestion index appear at the right. By signing in, users can perform historic analysis to determine what the impacts of a particular event or project might be, whether it is a parade, construction, or a serious crash.

[22] Regional Transportation Commission of Southern Nevada. (2012). Regional Transportation Plan, 2013-2035, p. 73.
[23] Regional Transportation Commission of Southern Nevada. (2012). Regional Transportation Plan, 2013-2035, p. 74.
[24] The FAST dashboard was recognized with a 2014 Data Innovation Challenge award for Traffic and Congestion Management by USDOT and a 2011 Institute of Transportation Engineers Achievement Award.

STEP 5.2.1	Program/Project Level: Determine monitoring framework

Figure 5-12: NDOT Coordinated Traffic Monitoring Interface

Source: RTC FAST Dashboard [25]



When an incident is detected by the ITS system, FAST operators flag the location on a live map, which automatically inputs temporal and spatial information about the incident and provides an area for an operator to input any additional data on the incident. Then, snapshots of the incident location as well as upstream and downstream locations are archived at 15-second intervals so that staff can have a visual reference and a timestamp for incident impacts and clearance rates.[26]

As an example, recent analysis of incidents on FAST revealed the impacts of large downtown conventions on the traffic patterns of Las Vegas's major corridors. Closely examining these patterns will enable RTC and partners in NDOT and the Metropolitan Police to better manage such large events and the traffic demands they entail. This includes the impact of police traffic direction, which assists by prioritizing access to and from event locations, but also contributes to corridor delays and beyond.

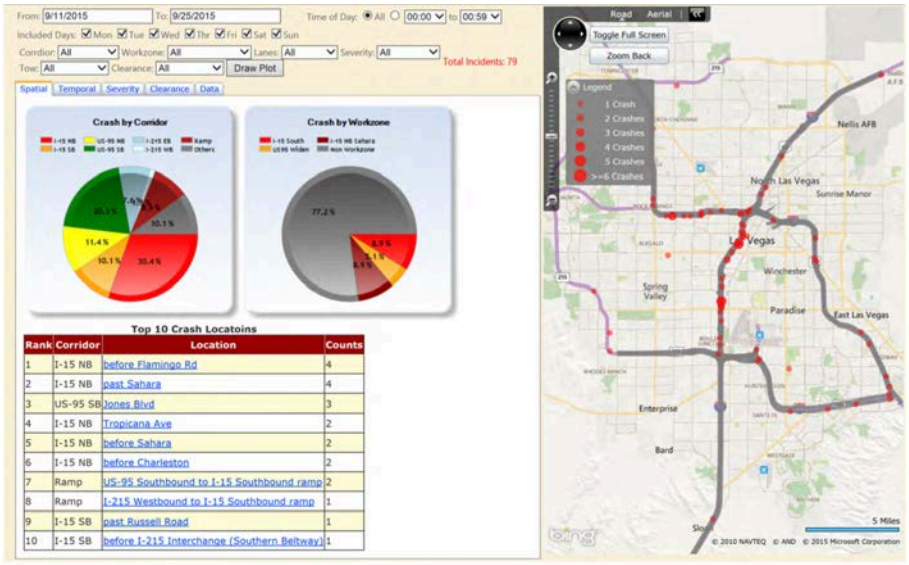
The detailed historic analysis enabled by FAST also shows congestion event and crash trends and helps RTC identify potential interventions. By providing historic performance data, FAST aided in making decisions, such as whether a full weekend closure or revolving weekday closures will cause less adverse effect when planning for a major construction project with NDOT. FAST can also pinpoint locations for safety interventions. When an expansion project on I-15 resulted in an increased number of crashes and delays, FAST pinpointed where restriping was needed to alleviate the issue. A snapshot of crash by corridor analysis is shown below.

[25] Nevada Department of Transportation - RTC FAST Dashboard. March 2, 2016. http://bugatti.nvfast.org/Default.aspx
[26] This information courtesy of Brian Hoeft, Director of FAST.

STEP 5.2.1	Program/Project Level: Determine monitoring framework

Figure 5-13: NDOT Coordinated Traffic Monitoring Congestion Analysis

Source: RTC FAST Camera Snapshot Wall [27]



FAST enables staff to determine location of, and then monitor the impacts of, smart fixes such as ramp metering, restriping, enhanced or interactive signage, and directly report progress toward RTC's congestion reduction and safety enhancement goals.

Linkages to Other TPM Components

Component 01: Strategic Direction (See TPM Framework)

Component 02: Target Setting

Component 04: Performance-Based Programming

Component C: Data Management

Component D: Data Usability and Analysis

STEP 5.2.2	Program/Project Level: Regularly assess monitoring results

Description

Using the monitoring framework, this step entails conducting performance diagnosis to determine root causes of the observed performance results (e.g., correlating traffic incidents with travel speed data; breaking down crash data by contributing factors recorded in crash records or highway inventories). Part of performance diagnosis means an examining and understanding of the factors impacting the effect programs and projects have on performance results. See below for a list of examples by TPM performance area (Table 5-4). If ongoing monitoring reveals that an agency is falling short of a performance target, this might indicate that the target was not realistic, the strategies were not effective, or one factor or a combination of factors threw performance results off course. In this step, analyze before and after performance results, in order to make a diagnosis.

[27] Nevada Department of Transportation - RTC FAST Dashboard. March 2, 2016. http://bugatti.nvfast.org/Default.aspx

STEP 5.2.2	Program/Project Level: Regularly assess monitoring results

Table 5-5: Explanatory Variables by Performance Area

Source: Federal Highway Administration

TPM Area	Explanatory Variables
General	Socio-economic and travel trends
Bridge Condition	Structure type and design Structure age Structure maintenance history Waterway adequacy Traffic loading Environment (e.g., salt spray exposure)
Pavement Condition	Pavement type and design Pavement age Pavement maintenance history Environmental factors (e.g., freeze-thaw cycles) Traffic loading
Safety	Population Traffic volume and vehicle type mix Weather (e.g., slippery surface, poor visibility) Enforcement Activities (e.g., seat belts, speeding, vehicle inspection) Roadway capacity and geometrics (e.g., curves, shoulder drop off) Safety hardware (barriers, signage, lighting, etc.) Speed limits Availability of emergency medical facilities and services
Air Quality	Stationary source emissions Weather patterns Land use/density Modal split Automobile occupancy Traffic volumes Travel speeds Vehicle fleet characteristics Vehicle emissions standards Vehicle inspection programs
Freight	Business climate/growth patterns Modal options – cost, travel time, reliability Intermodal facilities Shipment patterns/Commodity flows Border crossings State regulations Global trends (e.g., containerization)
System Performance	Capacity Alternative routes and modes Traveler information Signal operations/traffic management systems

STEP 5.2.2	Program/Project Level: Regularly assess monitoring results

Demand patterns
Incidents
Weather
Special Events

Below are a set of questions that can be used to start the performance diagnosis. While the specific questions will depend on the performance area you are looking at, the following types of questions will generally be applicable:

- What outputs have been produced as a result of the examined program or project (e.g., the miles of pavement repaved, the number of bridges rehabilitated, the number of new buses purchased)?
- What is the current level of performance?
- Is observed performance representative of "typical" conditions or is it related to unusual events or circumstances (e.g., storm events or holidays)?
- How does the current level of performance compare to past trends?
  - Are things stable, improving or getting worse?
  - Is the current performance part of a regular occurring cycle?
- What factors have contributed to the current performance?
  - What factors can we influence (e.g., hazardous curves, bottlenecks, pavement mix types, etc.)?
  - How do changes in performance relate to general socio-economic or travel trends (e.g., economic downturn, aging population, lower fuel prices contributing to increase in driving)?
- How effective have our past actions to improve performance been (e.g., safety improvements, asset preventive maintenance programs, incident response improvement, etc.)?

Example

Monitoring Winter Maintenance Practices: Rhode Island

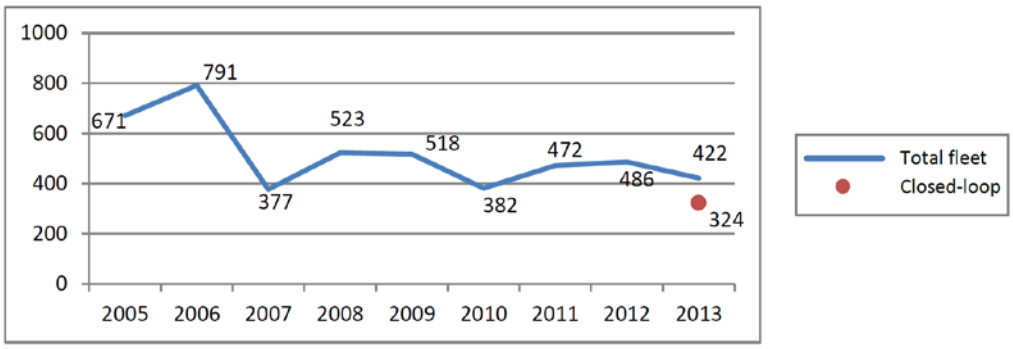
The Rhode Island Department of Transportation (RiDOT) is committed to reducing winter costs and alleviating environmental concerns related to its winter maintenance practices. In monitoring winter maintenance spending, RIDOT discovered a key driver of increasing costs was the use of salt products to treat roadways during winter storms. A potential solution, the installation of "closed-loop" systems in state-owned snowplows, was proposed by RIDOT staff. Closed-loop controllers provide more uniform salt and sand application and computerized data tracking resulting in reduction in material usage as compared to conventional spreaders. Closed-loop controllers would also enable RIDOT personnel to track material usage and application rates in specific locations.

RIDOT staff used the historical analysis of cost-drivers of the winter maintenance program and predicted savings from the closed-loop module to convince the budget office to let the agency use future savings to covert a portion of the winter vehicles to a "closed-loop" system. Once 20-30 percent cost savings was observed from lower salt usage (see figure below), RIDOT staff gained approval to install the equipment on 100 percent of the fleet. The understanding of a key driver of winter maintenance costs has allowed RIDOT to drive down roadway salt

STEP 5.2.2	Program/Project Level: Regularly assess monitoring results

application by more than 27 percent over the past seven years.[28]

Figure 5-14: RiDOT Winter Fleet: Average Pounds of Salt Per Lane Mile
Source: RiDOT Performance Report [29]



Linkages to Other TPM Components	Component 01: Strategic Direction	(See TPM Framework)
	Component 02: Target Setting	
	Component C: Data Management	
	Component D: Data Usability and Analysis	

STEP 5.2.3	Program/Project Level: Use monitoring information to make adjustments

Description

This step highlights the importance of actively using monitoring information to obtain key insights into the effectiveness of programs and projects and identify where adjustments need to be made.

Items to keep in mind as monitoring information is used to consider adjustments:

- **Passage of time.** Has enough time passed to gain a true picture of progress? The trajectory of progress is not always a straight-line movement; more data points may be necessary to fully understand the trend. Often, momentum can build or can be impacted by external factors over the measurement timeframe.
- **Constraints.** Agencies may be hindered from making program and project adjustments by TIP and RTP amendment cycles, budget development timeline, and legislative requirements (e.g., delivery of conformity model runs).
- **Anomalies.** Consider whether there were special circumstances driving the performance results. A single event or factor can have a sizable impact; if something atypical occurred such as a natural disaster or unexpected funding change, attempt to fully understand potential impacts to avoid making erroneous conclusions.
- **Reliability of predicted performance improvements from adjustment.** Before implementing any adjustments, agencies should analyze future performance. In general, predictive capabilities should allow agencies to compare the "do nothing"

[28] Statewide Planning Technical Paper Number: #000. Road Salt/Sand Application in Rhode Island. http://www.planning.ri.gov/documents/LU/RoadSaltTechPaper2013_12114rev.pdf
[29] Rhode Island Department of Transportation. (2013). Transportation Budget Fiscal Year 2013. Providence, RI. http://www.omb.ri.gov/documents/performance/performance-reports/all/1_Transportation_March%202013.pdf

STEP 5.2.3	Program/Project Level: Use monitoring information to make adjustments

scenario versus the potential impacts of adjustment (see Data Usability and Analysis, Component D)

After these considerations, determine whether a course correction is necessary. A communications strategy should be in place to ensure that stakeholders are informed and up to date on monitoring results and their consequences. If there are any changes, be sure that any new measures, goals, or targets are calibrated to the preceding ones to ensure continuity and understandable documentation.

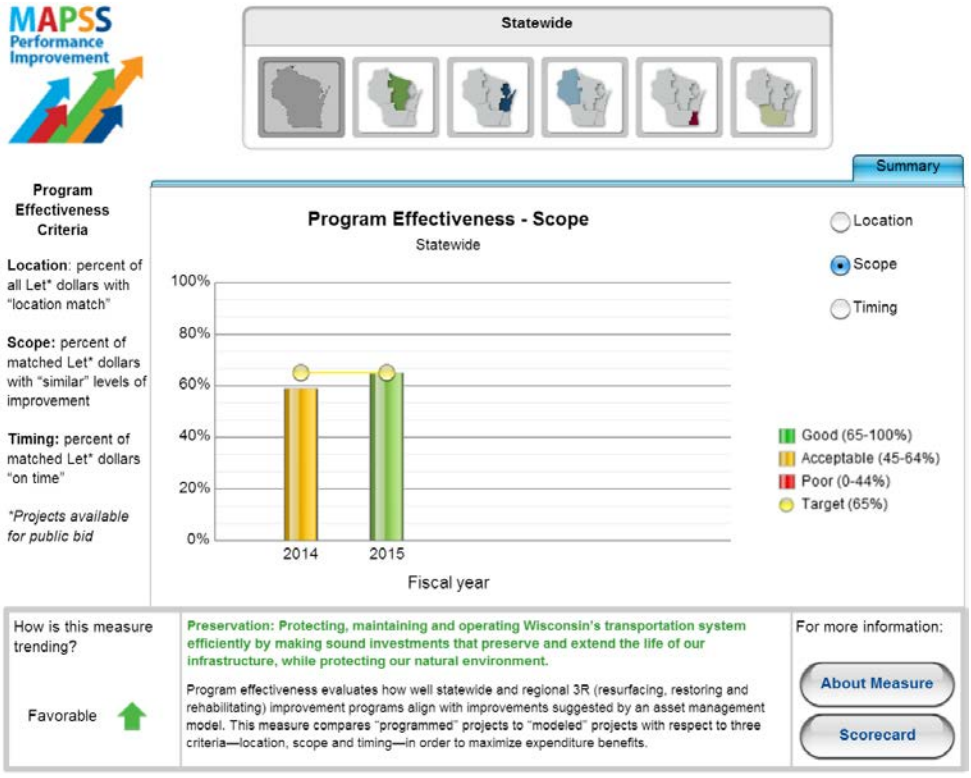
Example

Program Effectiveness Measure: WisDOT

The Wisconsin DOT uses a measure called Program Effectiveness to assess how improvement programs align with the agency's asset management model and performance-based plans. The measure is reported annually, and can be broken down into regions of the state and by location, scope, and timing of projects in reference to the model. Levels of performance are clearly indicated by color in the chart.[30]

Figure 5-15: WisDOT Regional Performance Effectiveness Scoring

Source: WisDOT [31]



[30] Wisconsin Department of Transportation - Program effectiveness. June 2, 2016. http://wisconsindot.gov/Pages/about-wisdot/performance/mapss/measures/preservation/program-effectiveness.aspx

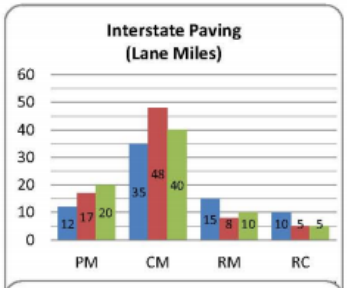
[31] Wisconsin Department of Transportation - Program effectiveness. June 2, 2016. http://wisconsindot.gov/Pages/about-wisdot/performance/mapss/measures/preservation/program-effectiveness.aspx

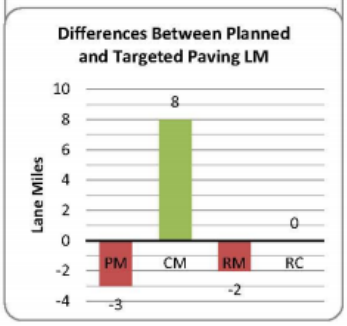
STEP 5.2.3	Program/Project Level: Use monitoring information to make adjustments

Pavement Management Adjustments: Virginia DOT

Virginia DOT (VDOT) uses a commercial Pavement Management System (PMS) with a companion pavement maintenance scheduling system tool (PMSS) to provide early warning of target non-attainment. This analysis is based on the status of planned paving projects, with the most recent pavement condition assessments and predicted pavement deterioration based on PMS performance models. The figure below illustrates one of the reports used to summarize planned versus targeted work by highway system class and treatment type. VDOT tracks project delivery and results on a statewide and district level. If issues are identified, VDOT makes adjustments to get back on track with predicted network-level pavement performance.

Figure 5-16: VDOT Pavement Maintenance Scheduling System Tool (PMSS)
Source: VDOT [32]





Hampton Roads Interstate Paving Summary

Preventative Maintenance (PM)
2011 Awarded (PMSS): 16 LM
2012 Planned (PMSS): 17 LM
2012 Targeted (PMS Optimized): 20 LM
Difference (Planned – Targeted): **-3 LM**

Corrective Maintenance (CM)
2011 Awarded (PMSS): 35 LM
2012 Planned (PMSS): 48 LM
2012 Targeted (PMS Optimized): 40 LM
Difference (Planned – Targeted): **+8 LM**

Restorative Maintenance (RM)
2011 Awarded (PMSS): 15 LM
2012 Planned (PMSS): 8 LM
2012 Targeted (PMS Optimized): 10 LM
Difference (Planned – Targeted): **-2 LM**

Reconstruction / Major Rehab (RC)
2011 Awarded (PMSS): 10 LM
2012 Planned (PMSS): 7 LM
2012 Targeted (PMS Optimized): 7 LM
Difference (Planned – Targeted): **0 LM**

Given planned 2012 Interstate paving, Hampton Roads District:
- **Is not** predicted to achieve its 20 lane mile paving target for Preventative Maintenance on the Interstate system.
- **Is** predicted to achieve its 40 lane mile paving target for Corrective Maintenance on the Interstate system.
- **Is not** predicted to achieve its 10 lane mile paving target for Restorative Maintenance on the Interstate system.
- **Is** predicted to achieve its 7 lane mile paving target for Reconstruction / Major Rehabilitation on the Interstate system.

Linkages to Other TPM Components

Component 01: Strategic Direction (See TPM Framework)

Component 02: Target Setting

Component A: Organization and Culture

Component C: Data Management

Component D: Data Usability and Analysis

[32] Virginia Department of Transportation. (2014). Use of VDOT's Pavement Management System to Proactively Plan and Monitor Pavement Maintenance and Rehabilitation Activities to Meet the Agency's Performance Target. Richmond, VA. https://vtechworks.lib.vt.edu/bitstream/handle/10919/56388/ICMPA9-000321.PDF?sequence=2&isAllowed=y

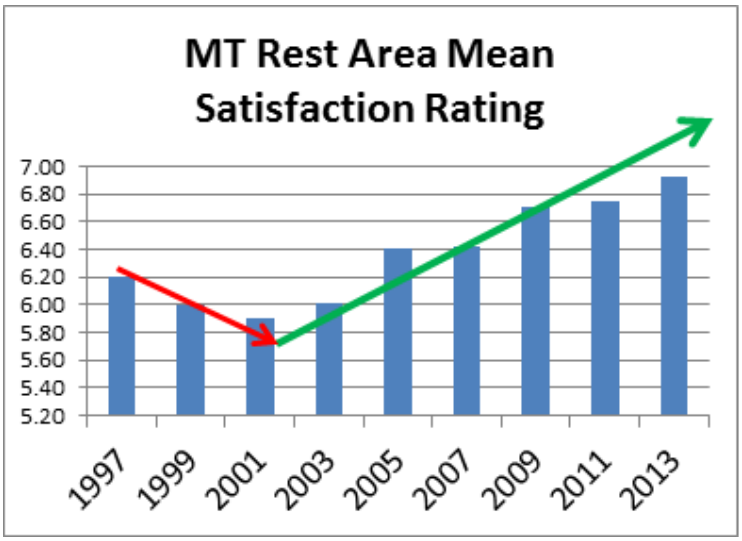
STEP 5.2.4	Program/Project Level: Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions
Description	This step creates the critical feedback loop between performance results and future planning, programming, and target setting decisions. To create an effective feedback loop, the monitoring information gathered and adjustments made to programs and projects need to be integrated into future strategic direction development (Component 01) and the setting of performance targets (Component 02). Through an increased understanding of the effect of specific projects and programs on outcomes, the monitoring and adjustment component uncovers information to be used in future planning (Component 03) and programming (Component 04) decisions. This component also helps agency staff link their day-to-day activities to results and ultimately agency goals (Organization and Culture, Component A). The external and internal reporting and communication products (Component 06) need to be based on the information gathered during monitoring and adjustment.  **Figure 5-17: Feedback Loop** Source: Federal Highway Administration
Example	As in other states, many of **Montana Department of Transportation's** (MDT) 49 state-maintained rest area facilities are at or nearing the end of their useful life, requiring substantial investment to remain operational. Though these facilities are expensive to build, operate, and maintain, the travelling public expects available, safe, clean rest stops. However, when rest area needs were placed side-by-side with roadways, these needs would often go unfunded, resulting in some rest areas being closed. To address this challenge, MDT established a rest area usage monitoring effort. For every facility in the state, MDT maintenance forces installed door counters ($250) at rest area entrances, installed potable water (non-irrigation) ($250) and wastewater (effluent flow meters) meters ($750) to create a time series data set and inform sound future investments. Usage determines all things – and reliable data means MDT could design and construct the right size facility, water supply, wastewater treatment system, parking lot, number of stalls, etc. MDT also better used and evaluated mainline traffic counts, especially permanent counters, to improve usage correlations to peak usage (time of year, time of day, etc.). The information gathered from these monitoring efforts and public complaints about rest areas triggered a series of rest area improvements being initiated even when competing with larger highway projects. The focused planning, investment, and research approach also created quantifiable project development and delivery efficiencies enabling MDT to do more with less. As customer satisfaction survey results reveal,[33] public perception and comments were very supportive of a rest area program grounded in monitoring and adjustment.

[33] Montana DOT. 2013 TranPlan 21 Public Involvement Survey: Volume 1 Final Report. https://www.mdt.mt.gov/publications/docs/surveys/2013_tranplan21_public_involvement.pdf

STEP 5.2.4	Program/Project Level: Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions

Figure 5-18: Rest Area Public Satisfaction 1997-2013

Source: TranPlanMT Public Involvement Surveys -2013[34]



Linkages to Other TPM Components	Component 01: Strategic Direction (See TPM Framework) Component 02: Target Setting Component 03: Performance-Based Planning Component 04: Performance-Based Programming Component 06: Reporting and Communication Component A: Organization and Culture Component C: Data Management Component D: Data Usability and Analysis

STEP 5.2.5	Program/Project Level: Document the process
Description	Document the process, including progress, outputs, outcomes, and any strategic adjustments and the reasoning behind these. This includes documentation for the purposes of internal operations, ensuring that the monitoring and adjustment process is replicable in future iterations of plans and throughout multiple planning efforts. It also includes steps toward gathering and organizing data (see Components C and D) in order to ensure that external reporting (Component 06) can be carried out in a sustainable and impactful way.

[34] Montana Department of Transportation. (2013). TranPlanMT Public Involvement Surveys -2013. Helena, MT. http://www.mdt.mt.gov/publications/surveys.shtml

STEP 5.2.5	Program/Project Level: Document the process

Examples

Several examples are offered here to illustrate how program/project level monitoring and adjustment processes and any subsequent changes to goals and targets are documented.

Program Delivery Monitoring at Southwestern Pennsylvania Commission (SPC)

SPC offers a large amount of documentation regarding each individual program area's monitoring and adjustment processes. As an example, within its congestion management program, SPC implements strategies under divisions of demand management, modal options, operational improvements, and capacity improvements. SPC documents all of the performance measurements and associated monitoring calculations directly on its website. [35] Gathered here are all the associated studies, reports, and other tools SPC uses to highlight, analyze, and evaluate the effectiveness of various congestion management strategies implemented.[36] As an example within this program, HOV lanes are listed as one strategy implemented to help reach congestion goals in the SPC region. SPC documents the reasoning behind the strategy and its relationship to the agency's congestion targets. Before and after analysis is completed using results from monitoring traffic delay, and detailed information is included as to how calculations were reached and compared. This ensures that the same monitoring process can be reproduced indefinitely, allowing ongoing understanding of how investment in HOV lanes has enabled SPC to progress toward its congestion reduction target and its mobility goals.[37]

Program Delivery Monitoring at Missouri DOT

In the last decade, faced with increasing costs and decreasing revenue streams, the Missouri Department of Transportation (MoDOT) revisited its pavement management program. Based on financial constraints, the agency decided to focus its efforts on improving major highways, rather than spreading resources out over minor roads as well, as had been done according to a previous formula. MoDOT established a target that would benefit the most users per dollar spent and relaxed its target for overall pavement condition that included minor roads. As a result of this adjustment, fewer resources were allocated to the preservation of minor roads, and the percentage of minor roads in good condition decreased from 71% to 60% from 2005 to 2009.[38] At the same time, however, MoDOT was able to respond to customers' desires for smoother roads by significantly improving the condition of major routes, from 47% in 2004 to 87% in 2009. Currently over 89% of major highways are in good condition, but MoDOT again must recognize that this condition level will be difficult to maintain without additional resources.[39] MoDOT used its Tracker performance measurement tool to document this adjustment to its performance targets and measures and to monitor and report the results, which are released quarterly.

[35] Southwestern Pennsylvania Commission, "Congestion Management Process: Performance Measures," http://www.spcregion.org/trans_cong_pm.shtml
[36] Southwestern Pennsylvania Commission, "Congestion Management Process: Strategy Implementation and Monitoring Effectiveness," http://www.spcregion.org/trans_cong_mon.shtml
[37] http://www.spcregion.org/pdf/cmpdoc/Operational%20Improvements/ParkwayNorth_HOVAnalysis_April2008.pdf
[38] Missouri Department of Transportation. (October 2014). *Tracker: Measures of Departmental Performance,* "Keep Roads and Bridges in Good Condition", p. 2a.
[39] Missouri Department of Transportation. (October 2014). *Tracker: Measures of Departmental Performance,* "Keep Roads and Bridges in Good Condition", p. 2a.

STEP 5.2.5	Program/Project Level: Document the process
	Documenting the decision to focus more resources on major routes rather than on the system overall was key to MoDOT's ability to measure progress moving forward and also to ensure stakeholders understood the adjustment. MoDOT measures its progress not only with typical performance measures but also through regular customer satisfaction surveys and focus groups to determine whether improvement projects are making the anticipated progress toward a satisfactory user experience—therefore communicating this strategy back to users using monitoring data was critical.[40] This documentation shows how the programs and projects implemented as MoDOT's pavement strategies are intended to impact progress toward performance targets.
Linkages to Other TPM Components	Component 01: Strategic Direction (See TPM Framework) Component 02: Target Setting Component 03: Performance-Based Planning Component 04: Performance-Based Programming Component 06: Reporting and Communication Component C: Data Management Component D: Data Usability and Analysis

[40] National Cooperative Highway Research Program. (2010). Transportation Performance Management: Insight from Practitioners. NCHRP Report 660. Washington, DC. p. 35. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_660.pdf

RESOURCES

Resource	Year	Link
TPM Toolbox	2016	www.tpmtools.org
Performance Based Planning and Programming Guidebook	2013	http://www.fhwa.dot.gov/planning/performance_based_planning/pbpp_guidebook/
Model Long Range Transportation Plans: A Guide for Incorporating Performance-Based Planning	2014	http://www.fhwa.dot.gov/planning/performance_based_planning/mlrtp_guidebook/fhwahep14046.pdf
Integrating Business Processes to Improve Travel Time Reliability	2011	http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-L01-RR-1.pdf
NCHRP Report 806: Guide to Cross-Asset Resource Allocation and the Impact on Transportation System Performance	2015	http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_806.pdf
NCHRP Report 660: Transportation Performance Management: Insight from Practitioners	2010	http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_660.pdf

ACTION PLAN

1. Of the TPM sub-components discussed in this chapter, which one would you like to work on?

❑ 5.1 System Level Monitoring and Adjustment ❑ 5.2 Program/Project Level Monitoring and Adjustment

2. What aspect of the TPM process listed above do you want to change?

3. What "steps" discussed in this chapter do you think could help you address the challenge noted above?

System Level

- ❑ Determine monitoring framework
- ❑ Regularly assess monitoring results
- ❑ Use monitoring information to make adjustments
- ❑ Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions
- ❑ Document the process

Program/Project Level

- ❑ Determine monitoring framework
- ❑ Regularly assess monitoring results
- ❑ Use monitoring information to make adjustments
- ❑ Establish an ongoing feedback loop to targets, measures, goals, and future planning and programming decisions
- ❑ Document the process

4. To implement the "step" identified above, what actions are necessary, who will lead the effort and what interrelationships exist?

Action(s)	Lead Staff	Interrelationships

5. What are some potential barriers to success?

6. Who is someone (internal and/or external) I will collaborate with to implement this action plan?

7. How will I know if I have made progress (milestones/timeframe/measures)?

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