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Target-Setting Methods and Data Management to Support Performance-Based Resource Allocation by Transportation Agencies - Volume I: Research Report, and Volume II: Guide for Target Setting and Data Management

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NCHRP REPORT 666

Target-Setting Methods and Data Management to Support Performance-Based Resource Allocation by Transportation Agencies

Volume I: Research Report
Volume II: Guide for Target-Setting and Data Management

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Academies was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program, conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council.

The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

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COOPERATIVE RESEARCH PROGRAMS

FOREWORD

By Andrew C. Lemer
Staff Officer
Transportation Research Board

NCHRP Report 666 describes methods that managers of state departments of transportation (DOTs) and other agencies can use for setting performance targets to achieve multiple objectives and interact with multiple decision-makers and stakeholder groups, and how data management systems within a DOT can support performance-based decision-making. Transportation agencies at all levels of government are embracing performance measurement to improve agency efficiency and accountability. Setting performance targets, a crucial step in the management process, generally entails balancing among competing objectives and dealing with political implications. Unless the bases for setting those targets are sound and defensible and key decision makers and stakeholders concur, the effectiveness of performance-based management is likely to be compromised. This report presents a framework and specific guidance for target-setting and for ensuring that appropriate data are available to support performance management. The report draws on a range of private- and public-sector examples to explore issues of data management and stewardship as well as organizational factors likely to influence an agency's performance measurement and management experience. Supplementing the report, *NCHRP Web-Only Document 154,* available on the TRB website, presents case studies of organizations investigated in the research. The information will be useful to senior agency managers seeking to develop and improve their performance-management practices.

DOTs and other transportation agencies are increasingly using performance measurement to guide their resource allocation decisions for operations, asset management, capital investment, planning, and policy development. There is extensive and growing literature on defining and applying performance measures, but little attention has been given to specific methods for setting performance targets. Setting targets within the context of a DOT generally entails balancing among competing objectives and considering the perspectives of multiple stakeholder groups. Unless performance targets are set with sound and defensible bases, and with the concurrence of key decision makers and stakeholders, the effectiveness of performance measurement as a management tool to improve agency efficiency and accountability is almost certain to be compromised.

Previous NCHRP-sponsored research has addressed limited aspects of performance measures and target-setting, for example, for asset management or project delivery. This report is the product of NCHRP Project 08-70, undertaken to develop a more comprehensive set of methods for establishing performance targets to guide resource allocation decisions in all aspects of DOT management, from planning and policy development to project implementation and operations. The research was designed to draw on a range of private- and public-sector examples to extract lessons that would be instructive and adaptable to transportation

agencies. Because effective performance measurement relies on good data, the research was designed also to describe data management systems and institutional relationships that will support DOT use of performance-based resource allocation.

The specific objectives of the research were to (1) describe a comprehensive framework and set of methods (a) to analyze opportunities to improve the multiple-objective performance of transportation systems within the context of broader societal goals and (b) to set specific performance targets to guide agency policies, plans, and programs; (2) detail the factors that influence target-setting and the success of performance-based resource allocation systems and explain how agencies may successfully design, implement, and use such systems; and (3) analyze the data and information needs, data acquisition and management systems, and institutional relationships required to support successful PBRA systems. Case studies of organizations that use performance-based resource allocation and other examples illustrate methods for presenting performance information to decision makers and other stakeholders and decision-support systems that can provide this information.

A team led by Cambridge Systematics conducted this research. The work started with a review of current private- and public-sector practices in using performance-based resource allocation to investigate the key elements of the performance-measurement and resource-allocation processes and the tools, data-management systems, and institutional relationships needed to support these elements.

The research team next sought to describe factors likely to influence the setting of performance targets in transportation agencies. Agency scope and organization; agencies' use of forecasting; availability, precision, and reliability of data within the agency; agencies' experience using benefit-cost analysis and other evaluation methodology; and stakeholders' perceptions and expectations were considered. Data management systems and institutional relationships to support performance-based resource allocation were given particular attention in the project work. The research results include specific guidance in two areas: performance target-setting as a factor affecting resource allocation and data management. Case-study reports of organizations investigated in the research are presented as well. These results are presented in this NCHRP report and the supplemental web-only document, *NCHRP Web-Only Document 154*, available on the TRB website.

An extension of the research being developed as these publications were in preparation will identify how risk analysis may best be used by transportation agencies in performance-based resource allocation. The extension will provide details on specific analysis methods and applications and on information technology tools and data sharing options to support target-setting in performance-based resource allocation.

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S U M M A R Y

Target-Setting Methods and Data Management to Support Performance-Based Resource Allocation by Transportation Agencies

In July 2006, representatives of several state Departments of Transportation (DOTs), Metropolitan Planning Organizations (MPOs), and the Federal Highway Administration (FHWA) met in La Jolla, California, to discuss the use of performance measures in resource allocation and the data systems required to support an emerging business practice known as performance management. The workshop produced several research statements that were funded in early 2007 through the NCHRP program, including this one titled Target-Setting Methods and Data Management to Support Performance-Based Resource Allocation by Transportation Agencies. The study was designed to help public sector transportation agencies develop and improve performance management practices through the following three key objectives:

- To provide an overall description of Performance-Based Resource Allocation (PBRA);
- To provide a comprehensive description of the process and methods by which targets are set for use in PBRA; and
- To provide a comprehensive description of the data, information systems, and institutional arrangements needed to support PBRA decision-making.

During the two years in which this study was conducted, there has been much discussion about the need to establish a performance–driven, outcome-based Federal Highway Program as a requirement of the next surface transportation authorization act. While this study was not intended to focus on a new national performance-based program, its findings and recommendations are none-the-less germane to the issues currently being debated regarding target-setting and data systems.

Framework for Performance-Based Resource Allocation

PBRA takes place within an overall Performance Management Framework, depicted in Figure S.1, which is comprised of six basic elements:

Establish Goals and Objectives. PBRA decisions are anchored in a set of policy goals and objectives which identify an organization's desired direction and reflect the environment within which its business is conducted. For example, many state DOTs have well-defined goals for the transportation system, including infrastructure condition, level of service and

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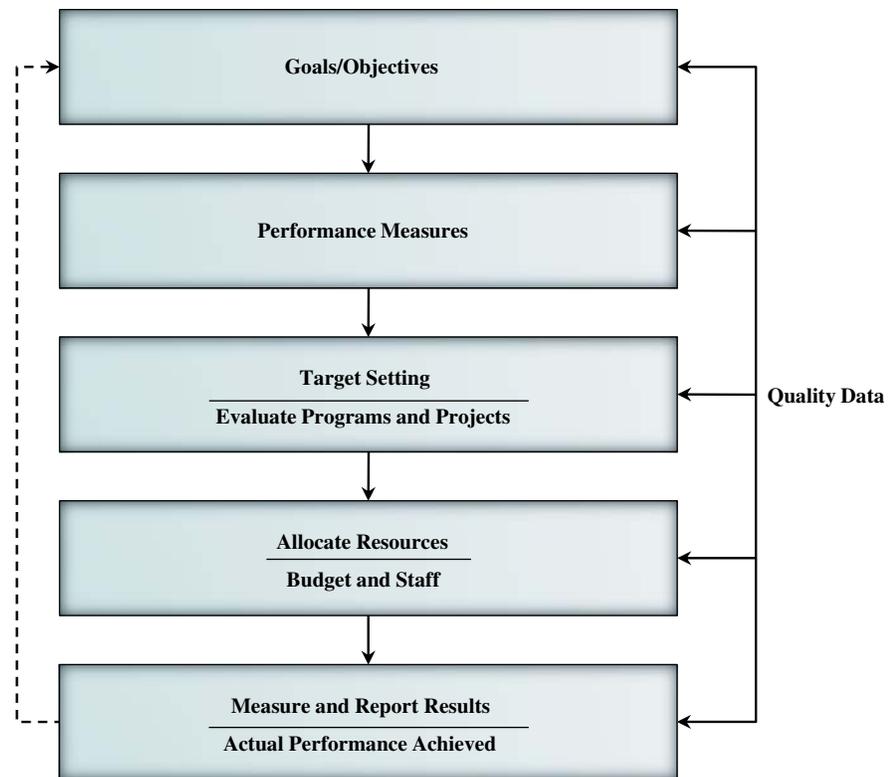
Figure S.1. Performance management framework.

safety, as well as goals reflecting economic, environmental and community values. Likewise the private sector frequently establishes policy goals to guide production of products and services while defining the environmental and community context for its investment decisions.

Select Performance Measures. Performance measures are a set of metrics used by organizations to monitor progress towards achieving a goal or objective. The criteria for selecting measures often include the following:

- Feasibility,
- Policy sensitivity,
- Ease of understanding, and
- Usefulness in actual decision-making.

Identify Targets. Targets are a quantifiable point in time at which an organization achieves all or a portion of its goals. These points set a performance level for each organizational measure, such as achieving a 25 percent reduction in highway fatalities by 2030. The methods used to set such a target include:

- Establish Performance Management Framework;
- Evaluate the Factors Influencing Target-Setting;
- Select the Appropriate Method(s) for Target-Setting;
- Establish Methods for Achieving Targets;
- Track Progress Towards Targets; and
- Adjust Targets Over Time.

Allocate Resources.   The allocation of resources (time and money) is guided by the integration of the preceding steps into an organization's planning, programming, and project development process. To the extent possible, each investment category is linked to a goal/objective, a set of performance measures, and a target. Specific investment proposals are defined in relation to specific targets.

Measure and Record Results.   The data for each performance measure must be regularly collected and periodically analyzed. The analysis should indicate how close the organization is to achieving its targets and identify the actions necessary to improve results. Many public and private sector organizations have tracking systems in place to monitor performance allowing senior staff to make periodic budget adjustments.

Create Data Management Systems.   "Good" data is the foundation of performance management. Effective decision-making in each element of the performance management framework requires that data be collected, cleaned, accessed, analyzed, and displayed. The organizational functions that produce these requirements are called data management systems. There are two key dimensions to creating and sustaining these systems. The two areas are equally important and must be synchronized within an organization to ensure the generation and use of accurate, timely, and appropriate data. The first area centers on the technical challenges associated with data systems, including development and maintenance of hardware and software, and the specifications for data collection, analysis, archiving, and reporting. The second area focuses on the institutional issues associated with data stewardship and data governance.

The Role of Targets in Performance-Based Resource Allocation

As indicated, performance management is a business process that links organization goals and objectives to resources and results. Performance measures, and their corresponding targets, are the lynchpin in the process. They provide the direct link between the stated goals of an agency and the effectiveness of its investment decisions in reaching those goals. Performance measures, used along with well-defined and well-communicated targets, provide transparency and clarity to the resource allocation decision-making process. Targets, themselves, provide the critical context for evaluating the effectiveness of investment decisions. For example, a performance measure will define how an investment decision will be evaluated in terms of its impact in absolute terms. The corresponding target, provides the perspective for evaluating the impact of the investment decision in relation to the desired end state, i.e., how significant is a particular investment in helping an agency attain a particular goal. Targets provide the means in which the relative effectiveness of a particular investment decision can be clearly communicated.

Because targets play such an important role in PBRA, this section of the study focused on the factors that influence target selection and the approaches by which targets are actually established. Towards that end, we have established the following steps for target-setting:

Step 1—Establish a Performance Management Framework.   Establish the framework that links organizational goals to resource results. Performance measures and their attendant targets are the link connecting goals to specific investments.

Step 2—Evaluate the Factors Influencing Target-Setting.   There are several internal and external factors in an agency that affect target-setting. These factors include—political/legislative influence, customer and stakeholder perspective, agency experience in using

performance measures and targets, commitment to regular communicating and reporting, span of agency control, financial resources, and timeframe. In assessing these factors and others, an agency needs to answer the following questions: Why is target-setting needed? Who will be using the targets? Where in the agency decision process will targets be used? When should targets be attained? How will targets actually be calculated? How will targets be achieved?

Step 3—Select the Appropriate Approaches for Target-Setting. Based on the factors in Step 2, select an approach or approaches for setting targets. Approaches for setting targets range from unilateral executive edicts based primarily on experience to collaborative senior staff decisions guided by relatively sophisticated modeling techniques available for some measures. In practice, however, most agencies use a hybrid approach in which they not only use different approaches for different measures but also multiple approaches for a single measure. For example, an agency could use modeling combined with customer/stakeholder feedback to arrive at a target that is both analytically grounded (to ensure a connection with predicted outcomes based on resources and existing plans) and satisfactory to the public and agency partners.

Step 4—Establish Methods for Achieving Targets. Within the context of the Performance Management Framework, identify methods that orient the agency and its resources towards achieving the targets set in Step 3. Public and private organizations alike use several specific methods to achieve targets. Most critical to this, broadly speaking, is the integration of performance measurement into daily agency activities. This directs attention to key issues, including financial resources and data support systems. Other methods include establishment of funding allocation incentives and the integration of performance target attainments into personnel performance appraisals.

Step 5—Track Progress Towards Targets. As part of the "Measure and Report Results" element of the Performance Management Framework, track performance progress specifically against targets. Virtually all public and private organizations that employ performance management track the impact of their investments in achieving specific targets. Techniques vary. Some use a Balanced Scorecard in which numerous measures are evaluated and tracked in terms of multiple perspectives (customer, finance, internal processes, learning, and growth) and simplified into tables of information providing "warning lights" for areas in need of improvement. Other organizations prepare periodic performance measure "snapshots" in which red, yellow, and green colored shapes represent annual progress relative to targets by geographic area. Other agencies publish annual attainment reports.

Step 6—Adjust Targets Over Time. Based on financial and political realities, ease, or difficulty of achieving targets, and increasing experience in PBRA, use the feedback loop in the Performance Management Framework to reevaluate and periodically adjust targets. Factors driving possible need for adjustments from a policy perspective include changes in the level of funding or in the rules governing project eligibility. When adjusting targets, agencies also should consider resolution of issues relating to model updates and data collection methodologies that may be influencing the calculation of the target.

Data Systems to Support Performance-Based Resource Allocation

Recent calls for more accountability in government have focused attention on the methods by which public agencies make decisions and the underlying data upon which those decisions are based. At the same time, transportation agencies are struggling with budget issues forcing the issue of getting the most "bang for the buck" through the examination of all programs to

ensure maximum value to the agency. With the pending Transportation Authorization and its certain emphasis on performance measures and data to support them, the issue of establishing and maintaining data programs at the state and regional levels to support these needs is prevalent. Federal needs for data to support national reporting and programming will continue to be a priority with programs such as the HPMS reassessment, Intellidrive, and Freight Data Management to name a few. Furthermore, state transportation improvement programs are emphasizing more collaborative transportation decision-making, which in-turn requires improved data programs.

PBRA in any organization relies on the availability of timely, accurate, high-quality data which is easily accessible through a framework known as a data system. Various data systems throughout the organization serve the needs of decision-makers in multiple business areas. Data are the basic pieces of information which, when processed through a system, are available for analysis. The core data pieces transform into information, and decision-makers then use this information to manage business functions across the organization. The process for ensuring that data is of the highest quality possible is known as a data management process. Data management programs are used to manage the data systems within the organization.

Data management can be defined as the development, execution and oversight of architectures, policies, practices, and procedures to manage the information life-cycle needs of an enterprise in an effective manner as it pertains to data collection, storage, security, data inventory, analysis, quality control, reporting, and visualization. There are many ways to approach establishing a data management program, however, one of the most effective ways is to incorporate data management in concert with an overall data governance framework.

Data governance can be defined as the execution and enforcement of authority over the management of data assets and the performance of data functions. The implementation of data governance includes participants from many areas of the organization. These individuals are usually already performing many of the roles identified with data governance, but their job functions have not been aligned within a formal data governance structure. For instance, persons within a business unit who enter data into a system and are responsible for the quality of the data are referred to as data stewards within the data governance model.

A hierarchical relationship exists between data management, data governance, and data stewardship as illustrated in Figure S.2.

Besides those who collect and provide data, there are users of the data, known as stakeholders. These stakeholders form a Community of Interest (COI) for the data system. The COIs serve a vital role by identifying needs for data and information and helping to determine where the gaps exist in data programs. This leads to a formalized process for evaluating and ranking priority needs for future data systems, and for justifying the costs of such data program development, based on Return on Investment (ROI) to the organization. Assessment of existing data systems also is a key component of a strong data management program.

The following steps outline how transportation agencies can use data management and governance to strengthen existing Performance Measurement and Target-Setting programs in the agency.

- **Step 1—Establish the Need for Data Management/Governance.** Define the important relationship between data management and performance measurement and provide a maturity model to assess the "state of data governance" at the organization.
- **Step 2—Establish Goals for Data Management.** Once an agency has committed to making improvements in their data management practices, a plan to achieve this should be developed. A strong Data Management program improves data quality and limits potential risks to the agency regarding loss of critical data and information.

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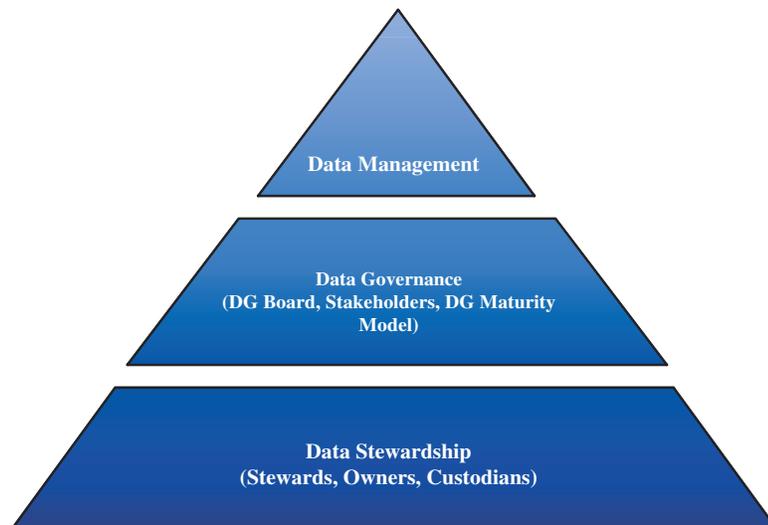
Source: Modified from Figure 1 Data Governance Team, The Data Governance Maturity Model. White Paper, RCG Information Technology, 2008.

Figure S.2. Data management, data governance, and data stewardship.

- **Step 3—Assess Current State of Data Programs.** There are tools and techniques available to assist the organization in assessing the current data practices and programs. These tools are known as Business Intelligence (BI) tools, and this report provides several examples of the use of BI tools in the Case Studies documented in Volume III.
- **Step 4—Establish Data Governance Programs.** The agency should develop and implement a data governance framework model that best meets the needs of the organization. There is not a one-size fits all data governance model. Figure S.3 illustrates a generic data governance framework which includes all of the traditional participants in a data governance model.
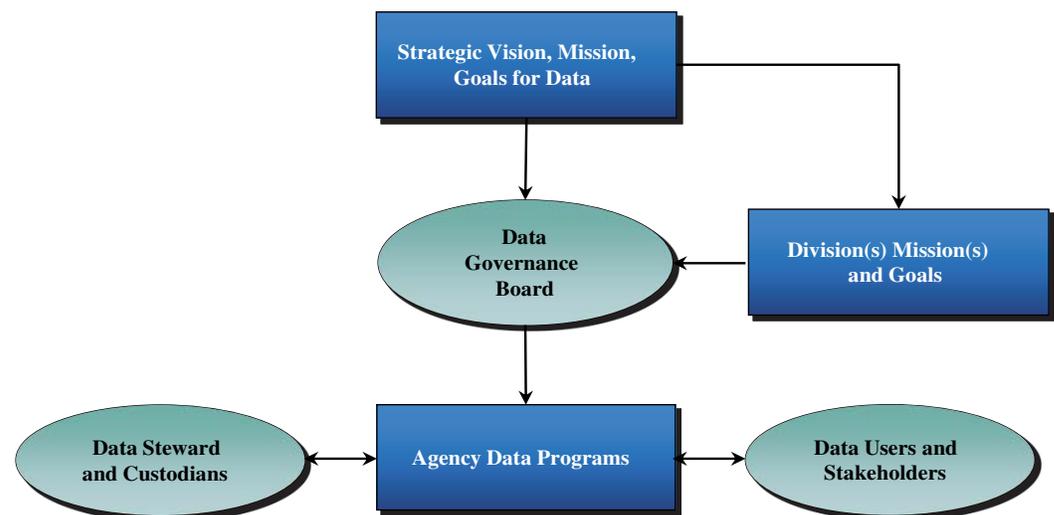
Figure S.3. Standard data governance model.

An important part of establishing the data governance model is to align the goals of the data programs to the business objectives of the agency as a whole. This is accomplished through the following steps:

 – **Step 4.1**—Identify the business objectives of the agency.
 – **Step 4.2**—Identify the business functions or services of the agency that support the business objectives.
 – **Step 4.3**—Identify which business functions are supported by which data programs.
 – **Step 4.4**—Establish policies, standards, and procedures which mandate how data is to be collected and used within the agency.
 – **Step 4.5**—Establish Data Action plans on both a data program and enterprise level, to address needs and gaps in data and information across the agency.
 – **Step 4.6**—Establish a risk management plan for protecting data programs as valuable assets of the agency.
- **Step 5—Technology for Data Management.** The agency should utilize the tools available to support data management, including knowledge management systems, risk management systems, geographic information systems (GIS), and visualization tools, such as dashboards and scorecards.
- **Step 6—Link Data Program to Planning, Performance Measures, and Target Processes.** The agency should demonstrate how the data programs are linked to planning, performance measures, and targets. This can be done through business use case examples and concept of operations documentation.

Importance of a Data Business Plan

The establishment of a data management program in a transportation agency can be achieved through the use of a formal data business plan. Many agencies incorporate components of their strategic plan into the data business plan, to ensure that data programs are aligned with the strategic mission and objectives of the agency.

A data business plan helps to:

- Establish goals;
- Assess agency data programs;
- Establish data governance;
- Ensure proper use of technology/tools; and
- Link data management to performance measures and target-setting.

There is a variable cross-section in state transportation agencies from those that have developed and implemented data business plans, such as Virginia DOT, to those who have made good progress in developing a data business plan, such as Alaska DOT, and those have just begun the process to develop a data business plan. Still others have not formalized a data business plan for their agency but can still derive benefit from examining the examples provided by peer states.

Target-Setting and Data Management Challenges and Opportunities

It is important to acknowledge that there are both challenges and opportunities associated with setting performance targets and establishing a performance management data business plan. The opportunities derive from a transparent data-based decision process that clearly defines the nature of agency investments. The challenges are both institutional and technical in

nature. There are many examples, however, from both the public and private sector in which organizations specializing in transportation not only demonstrate the use of performance targets but also illustrate how data management and data governance are used to manage data programs which support performance measurement. These examples are all detailed in Volume III of the report, the Case Studies. Each of the challenges offers an opportunity to improve target-setting and the delivery of data and information to decision-makers across the organization.

As illustrated in the Performance Management Framework in Figure S.1, data is a very important factor in the PBRA process. For instance, once an operational data management program is implemented, it needs to be integrated with the agency performance measures and target-setting process. The success factors to achieving this critical step are the following:

- Use a hybrid approach that employs modeling and benchmarking to establish agency targets and performance measures.
- Do not use a one size fits all approach in establishing performance measures and targets. Use the correct metrics for making decisions. Focus on continuous improvement by revising/adding new metrics as needed.
- Link the performance measures and targets for a program to budget allocations, improving participation by staff in supporting the performance measures and targets. The performance measure and target-setting process also can be used to motivate employees by linking their performance plans to objectives identified in specific performance measures and targets.
- Allow DOT transportation planning staff routine access to other planning offices (regional, district, etc.) and technical resources available in the agency. This strongly enhances a performance-based management process.
- Reward business areas which consistently meet targets and goals. Consistent achievement in meeting targets is a powerful motivator for behavior—success breeds success.
- Use external data sources, such as environmental, historic, and other planning agencies for GIS data layers to improve the data used for the performance measurement process when funds are limited to collecting this data using internal resources.
- Utilize software that is procured or developed internally to automate as much of the performance measurement process as possible. This will allow for more time devoted to the analysis of the performance results.
- Revise or stop using targets if performance data are not easily obtainable when a performance target is used.
- Programs which do not have a direct link between that program or project and performance should not be funded.
- Identify business units responsible for maintaining current metadata about each performance measure. This facilitates the analysis required for user requested data and information system changes and enhancements.
- Include objectives pertaining to resource allocation in the agency Business Plan. The current Business Plan at the Maryland Transportation Authority (MDTA), for example, has three separate objectives related to resource allocation. These include System Preservation, Implementing and Asset Management System, and Integrating MDTA's financial system with other systems.
- Use external data sharing agreements to obtain data for performance measures that the agency does not have. For example, MDTA collaborates with other agencies for several measures that it needs additional data for, or does not have the necessary equipment to monitor itself.
- Establish performance targets through a streamlined process and revisit and revise (as needed) periodically.

- Incorporate customer satisfaction as a measure in setting performance targets.
- Utilize incentives to facilitate meeting performance objectives, including awarding bonuses based upon job performance and using quantitative objectives embedded in professional employees' annual objectives.
- Arrange performance measures in a hierarchical order, allowing an agency to translate strategic goals/objectives into operational goals/objectives for each department. The U.S. DOT follows this approach among its various administrations (e.g., FHWA and FTA), allowing it to provide a performance budget that can be related to actual and planned accomplishments for each department. This same scenario would apply to a state DOT, with several divisions, districts, and/or independent offices. The performance in each area then becomes a key basis of resource allocation and budgeting.

It is ultimately up to the transportation agency to take full advantage of the benefits that a fully functional data management program will offer for decision-making in a transportation environment.

Research Report

C O N T E N T S

CHAPTER 1

Introduction

1.1 Project Purpose

The overall scope of NCHRP Project 8-70, "Target-Setting Methods and Data Management to Support Performance-Based Resource Allocation by Transportation Agencies" is designed to assist public sector transportation agencies develop and improve performance management practices through the following three key objectives:

- To provide an overall description of performance-based resource allocation (PBRA);
- To provide a comprehensive description of the process and methods by which targets are set for use in PBRA; and
- To provide a comprehensive description of the data, information systems, and institutional arrangements needed to support PBRA decision-making.

1.2 Project Approach

The report proceeded through three phases. In Phase 1, the research team accomplished the following objectives:

- Describe the purpose, desired outcomes, and essential elements of PBRA;
- Develop a list of public and private organizations reviewed that use all or part of the performance management process, including examples of how organizations apply each element but with a focus on target-setting;
- Identify the fundamental differences and similarities between objectives for a public sector agency and a private sector organization;
- Develop the criteria that will be used for selecting case studies and the form that case study documentation will take; and
- Prepare the questionnaire that will be used in case studies.

Building from this foundation, Phases 2 and 3 were conducted simultaneously, providing a detailed description of the case studies selected in Phase 1 and focusing on the following:

- Performance Targets:
  - The role of targets in PBRA;
  - Factors influencing target-setting; and
  - Approaches to target-setting.
- Data Stewardship and Management:
  - Elements of effective data stewardship and management;
  - Institutional issues related to data stewardship and implementation of data governance;
  - Data sharing, documentation, and reporting;
  - Key technical considerations that guide setting data requirements and data management system development; and
  - Summary of success factors related to effective data management systems and institutional relationships to support PBRA.

1.3 Organization of the Report

This report is organized in three volumes. Volume I is the research report that focuses on the target-setting and data management elements of the performance management framework. Volume II provides the actual guidance for target-setting and data management and is a freestanding document. Volume III, which will be published on the TRB website as *NCHRP Web-Only Document 154,* is the case studies that provide the resource material upon which the study and guidance are based.

Volume I

This volume provides findings and conclusions from all three phases of NCHRP Project 8-70. It describes a Performance Management Framework within which both state Departments of Transportation (DOTs) and Metropolitan Planning Organizations (MPOs) can develop and implement a PBRA decision process. It focuses on two elements of the framework—target-setting and data management systems.

Chapter 2 describes the Performance Management Framework which includes Goals and Objectives, Performance

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Table 1.1. NCHRP Project 8-70 case study organizations.

Organization	Organization Type
City of Coral Springs, Florida	Local Government
Hennepin County Public Works	Local Government
U.S. Army ARDEC	Federal Government
GASB Statement 34	Federal Government
U.S. DOT	Federal Government
Japan Ministry of Land, Infrastructure, and Transport	International
Atlanta Regional Commission	MPO
Metropolitan Transportation Commission	MPO
Orlando-Orange County Expressway Authority	Toll Authority
Port Authority of New York/New Jersey	Port/Transit/Other
Kansas State Department of Education	Education
ABC Logistics	Private
Corporation X	Private
Do-it-Yourself Retailer	Private
Multinational Conglomerate	Private
RCG Information Technology	Private
Florida DOT/State Government	State DOT
Minnesota DOT	State DOT
Ohio DOT	State DOT
Washington DOT/State Government	State DOT
Maryland DOT (State Highway Administration, Motor Vehicle Administration, Maryland Transportation Authority)	State DOT/Transit/Other

Measures, Targets, Resource Allocation, Reporting Results, and Data. It also describes several emerging trends in U.S. transportation industry practice.

Chapter 3 describes the role of targets in PBRA in both the public and private sector. It outlines the factors that influence target-setting and methods by which targets are actually set.

Chapter 4 summarizes the ways data management systems and organizational units within a DOT are used to ensure the use of accurate, timely, high-quality data for decision-making purposes. Two dimensions are involved in this process. The first focuses on the technical challenges associated with data systems and the second focuses on the institutional and organizational challenges associated with data stewardship and data governance.

Volume II

Volume II of this report provides guidance for state DOTs and MPOs on setting targets and establishing data systems to support PBRA.

Chapter 1 provides a process that can be used by transportation agencies for developing and evaluating performance measure targets. The process consists of the following six steps:

1. Establish a Performance Management Framework,
2. Evaluate the Factors Influencing Target-Setting,
3. Select the Appropriate Approach for Target-Setting,
4. Establish Methods for Achieving Targets,
5. Track Progress Towards Targets, and
6. Adjust Targets Over Time.

Chapter 2 explains how transportation agencies can use data management and governance to strengthen existing performance measurement and target-setting programs. It applies the research conducted in Phase 3 into practical guidance for transportation agencies. The Guide is organized under the following headings:

- 2.1 Establishing the Need for Data Management/Governance;
- 2.2 Establishing Goals for Data Management;
- 2.3 Assessing the Current State of Data Programs;
- 2.4 Establish Data Governance Programs;
- 2.5 Technology for Data Management; and
- 2.6 Linking Data to Planning, Performance Measures, and Target-Setting Processes.

Volume III

This volume, which is published on the TRB website as *NCHRP Web-Only Document 154,* provides a description of the case studies to which the guidance in Volume II is linked. The list of organizations interviewed and provided as case studies in Volume III is shown in Table 1.1. The case studies serve as specific examples which illustrate the use of performance targets and data support systems for resource allocation within the Performance Management Framework.

CHAPTER 2

Performance-Based Resource Allocation

Responding to trends in the 1990s that placed greater emphasis on public-sector accountability for more effective performance, state and local transportation agencies initiated a number of programs such as transportation asset management, performance-based planning, management and budgeting, and maintenance quality assurance, among others. These efforts promoted a policy-driven, performance-based approach to managing and developing infrastructure that encouraged identification of alternative solutions, use of economic methods (e.g., minimization of life-cycle costs and benefit/cost analysis), explicit consideration of tradeoffs in program resource allocation, use of quality information through formal data collection programs, and applications of automated decision-support systems. They also promoted definition of performance measures and targets based upon stated policy objectives and input from public outreach. These efforts coincided with innovations in planning, programming, and more flexible funding in Federal surface transportation legislation beginning with the Intermodal Surface Transportation Efficiency Act (ISTEA 1991), as well as growing interest in different approaches to solving transportation problems through greater understanding and use of transportation operations solutions and associated intelligent transportation systems (ITS) technology. Documents such as the Federal Highway Administration's (FHWA) Asset Management Primer; American Association of State Highway and Transportation Officials' (AASHTO) Transportation Asset Management Guide [a product of NCHRP Project 20-24(11)]; *NCHRP Report 545: Tools for Asset Management Tradeoff Analyses;* and *NCHRP Report 551: Performance Measures and Targets for Transportation Asset Management* reinforced these approaches among practitioners.

These studies laid out the concepts, procedures, and information needed for a performance-based approach to resource allocation and many state and local agencies have benefited from improved decision processes resulting from their adoption and implementation. At the same time, a number of other agencies still find it difficult to adopt such an approach in their transportation programs. As a result, recent and ongoing research shows considerable variability in agency resource allocation capabilities and practices nationwide.

Some agencies have the tools needed for performance-based asset management, e.g., well developed statements of policy objectives and performance targets, modern infrastructure management systems, data collection and processing procedures to support both performance monitoring and management system application, and an organizational culture that supports strong communication and coordination horizontally and vertically. In contrast, other agencies lack even basic elements, such as inventories of assets and defined performance measures. Furthermore, a vicious cycle ensues: agencies that lack the data and analytic tools needed to show a declining condition and performance of their assets find themselves unable to justify spending more (in staff effort as well as dollars) to improve their asset management processes that would enable them to do better, PBRA.

In spite of uneven implementation among state departments of transportation, performance management has been evolving steadily into an effective business process that links organizational goals and objectives to resources and results. Performance measures, and their attendant targets, are the lynchpin in this process. They are the link connecting goals to specific investments. The methods, including underlying data support systems, by which the measures and targets are established, play a critical role in the overall success of a public agency or private company.

PBRA takes place within an overall Performance Management Framework, depicted in Figure 2.1, which is comprised of six basic elements described in the following paragraphs.

Establish Goals and Objectives. PBRA decisions are anchored in a set of policy goals and objectives which identify an organization's desired direction and reflect the environment within which its business is conducted. For example, many state DOTs have well-defined goals for the transportation system,

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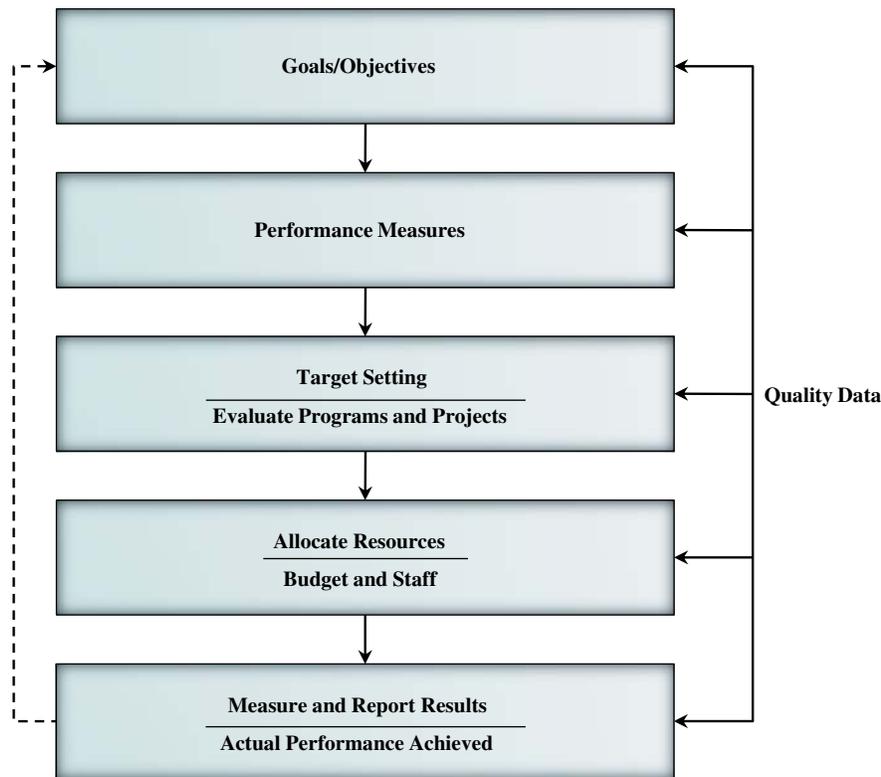
Figure 2.1. Performance Management Framework.

including infrastructure condition, level of service and safety, as well as goals reflecting economic, environmental, and community values. Likewise the private sector frequently establishes policy goals to guide production of products and services while defining the environmental and community context for its investment decisions.

Select Performance Measures.   Performance measures are a set of metrics used by organizations to monitor progress towards achieving a goal or objective. The criteria for selecting measures often include the following:

- Feasibility,
- Policy sensitivity,
- Ease of understanding, and
- Usefulness in actual decision-making.

Identify Targets.   Targets are a quantifiable point in time at which an organization achieves all or a portion of its goals. These points set a performance level for each organizational measure, such as achieving a 25 percent reduction in highway fatalities by 2030. The methods used to set such a target include the following:

- Establish a Performance Management Framework,
- Evaluate the Factors Influencing Target-Setting,

- Select the Appropriate Method(s) for Target-Setting,
- Establish Methods for Achieving Targets,
- Track Progress Towards Targets, and
- Adjust Targets Over Time.

Allocate Resources.   The allocation of resources (time and money) is guided by the integration of the preceding steps into an organization's planning, programming, and project development process. To the extent possible, each investment category is linked to a goal/objective, a set of performance measures, and a target. Specific investment proposals are defined in relation to specific targets.

Measure and Record Results.   The data for each performance measure must be regularly collected and periodically analyzed. The analysis should indicate how close the organization is to achieving its targets and identify the actions necessary to improve results. Many public and private sector organizations have tracking systems in place to monitor performance allowing senior staff to make periodic budget adjustments.

Create Data Management Systems.   "Good" data is the foundation of performance management. Effective decision-making in each element of the performance management framework requires that data be collected, cleaned, accessed,

analyzed, and displayed. The organizational functions that produce these requirements are called data management systems. There are two key dimensions to creating and sustaining these systems. The two areas are equally important and must be synchronized within an organization to ensure the generation and use of accurate, timely, and appropriate data. The first area centers on the technical challenges associated with data systems, including development and maintenance of hardware and software, and the specifications for data collection, analysis, archiving, and reporting. The second area focuses on the institutional issues associated with data stewardship and data governance.

2.1 Current Practice Among State DOTs

Within transportation the application of performance measures has an especially long history. These historical roots are likely due in part to the fact that transportation programs deal with engineered facilities and ongoing operational services that have been supported by well-established funding mechanisms, a strong research culture, and extensive statistical reporting. What has changed today, however, is the context in which performance monitoring and reporting are conducted, and to what purposes. There is a much stronger emphasis today on the need to demonstrate responsiveness to customer needs, accountability for program expenditures, and provision of satisfactory levels of service or results. Well-executed performance-based management and reporting helps an agency to maintain credibility with executive and legislative bodies in justifying requested budgets and demonstrating wise use of public funds.

This current study is at the focal point of the following emerging trends in U.S. transportation industry practice:

- Increased use of performance measurement in policy, planning, and programming. DOTs and other transportation agencies are learning how to apply performance measures to their resource allocation decisions and to understand the elements and best practices needed to implement performance measures successfully as part of their day-to-day management. Nonetheless, while applying performance measures is conceptually straightforward, there are many details. The simplicity of the performance measurement idea belies the challenges and the levels of effort and commitment that are actually involved in putting the idea into practice.
- Formalization of asset management concepts and principles drives agencies towards a policy-driven, performance-based approach to resource allocation and utilization, explicit consideration of alternative solutions, analyses of tradeoffs in terms of cost versus performance, and project and program evaluation methods and criteria that, through the use of

performance measures, are consistent with policy objectives and targets.
- Development and application of maintenance quality assurance programs, which entail explicit maintenance levels of service that, like performance measures, can serve as both indicators of the current condition/performance of maintained features in the transportation system and expressions of target values for improvement. Several DOTs have successfully moved concept into practice by incorporating maintenance levels of service within performance-based budgeting tools for their maintenance programs.
- A renewed focus on analytic tools and other information technology resources that are needed for performance-based management. Data collection and processing, making needed information accessible to all organizational levels across the agency, implementing useful management systems and other analytic tools, and aligning systems and data with an agency's business processes are critical to effective decision support for policy-making, planning, and resource allocation. Cost-effective data collection procedures and technology, updated organizational responsibilities for managing shared data, taking the best advantage of the substantial investment in legacy systems while providing new capabilities where needed, and ensuring the quality and accessibility of data to a diverse set of agency and stakeholder users are some of the key challenges that are now being dealt with by DOTs in this area.
- An increased focus on the development of a risk management plan as part of a performance measure program. While there was some consideration of the need for a formal risk management plan before the Minnesota bridge event, assessing risk across the enterprise has become a higher priority.[1]

Ways in which agencies have responded to these trends using performance-based management are summarized in a recent report by AASHTO's Performance-Based Highway Program Task Force titled *A Primer on Performance-Based Highway Program Management: Examples from Select States*.[2] The report profiles the experiences of DOTs in 11 states: California, Florida, Maryland, Michigan, Minnesota, Missouri, Montana, New York, Ohio, Virginia, and Washington. Agencies' functions are described in one or more of the following management areas:

- Policy development and long-term planning;
- Programming and budgeting;

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[1]Eighth National Conference on Transportation Asset Management (http://pressamp.trb.org/conferences/programs/program.asp?event=486).
[2]*A Primer on Performance-Based Highway Program Management: Examples from Select States.* American Association of State Highway and Transportation Officials, Washington, D.C., January 2008. Accessed March 13, 2008. http://www.transportation.org/sites/quality/docs/PeformanceBasedHighwayProgram_Jan 2008.pdf.

- Program, project, and service delivery;
- System operations; and
- Monitoring and reporting results.

The ways in which performance measures are engaged by these functions involves the following elements of comprehensive performance management:

- To select appropriate measures to gauge agency performance in critical program and service areas;
- To track and report actual results and, where appropriate, to compare to stated objectives, targets, or benchmarks;
- To analyze results to identify key factors influencing performance and opportunities for improvement;
- To allocate resources and operate transportation systems to drive better results; and
- To continue to monitor and report progress.

The AASHTO *Primer* also notes that performance measurement is not a silver bullet and does have inherent limitations. For example, not all aspects of transportation system performance are under the control of an owning/operating agency. Performance data may signal a change in some aspect of transportation system condition or operation but do not necessarily indicate the cause of that change. Some important aspects of performance are not easily measured. Even where performance outcomes can be measured, that information may be only a part of what decision-makers need in their deliberations. Nonetheless, the value of performance measurement as part of the total package of information available to an agency has been well validated in the experiences of several of the DOTs that have been described in the AASHTO *Primer*.

Profiles of each of the 11 state DOTs are presented in the AASHTO *Primer* in this context. The AASHTO *Primer* observes that the 11 DOT profiles demonstrate the following benefits of comprehensive performance-based management:

- More efficient allocation of increasingly scarce resources;
- Development and justification of budget and project proposals; and
- Accountability to road users and the general public for decisions in funding, constructing, maintaining, and operating the highway system.

Given the objectives and perspectives of this study, these DOTs that appear to have gone the furthest in applying performance-based thinking to investment decisions, programming, and resource allocation illustrate several elements of best practice:

- The application of performance measures throughout the agency that are integrated vertically, horizontally, and among processes. Process-related integration implies top-to-bottom consistency of performance measurement concepts, tools, and measures throughout several key functions: e.g., policy formulation, data collection/analysis, long-range and short-term planning, programming/budgeting/resource allocation, program/project delivery, and system monitoring/feedback. Horizontal integration implies consistency in performance measurement across agency divisions and business units. Vertical integration implies consistency in performance measurement (though at different levels of detail) among levels of management. Several agencies described this approach as *holistic.*
- The application of performance measurement in a systematic, documented way. Performance measurement is embodied in a number of documents that represent a progression of thinking. Each document marks the successful completion of findings for a particular function and provides guidance for the subsequent function. Long-term plans, short-term components, work programs, STIP documents, approved budgets with project lists, and performance monitoring/tracking reports are examples of a systematic approach that enforces the consistent, integrated processes of the previous bullet.
- Strong executive/managerial support and involvement in performance reviews and decisions on reallocating resources, in central and district offices, as well as among program and key business unit managers.
- Recognition that performance measurement can involve a culture change within the agency, with steps taken to focus on the positive aspects of this change while mitigating the potentially negative aspects.
- Transparency of performance results and their implications for transportation customers and stakeholders, as well as the owning/operating agency. State DOTs take different approaches to this need—e.g., some favor devices such as dashboards, report cards, or score cards, while others prefer a more narrative or descriptive communication. All of these approaches appear to be successful in the context in which they are used. The important point is the recognition that technical data that characterize transportation network conditions, operations, work needs, services, and programs need to be translated into a form that different audiences understand and can respond to.
- Several agencies look at organizational performance, as well as transportation system performance, and a subset of these links the two concepts: i.e., transportation system performance influences the performance evaluation of agency business units and employees. This concept has existed for some time in the private sector but now is being considered by public sector DOTs.

NCHRP Project 20-60 considered performance measures and targets in the context of asset management within state

DOTs.[3] Asset management is by definition a policy-driven, performance-based process that stresses, among other attributes, the use of quality data and analytic tools, including predictive models. Management principles, methods, and decision criteria that are rooted in asset management thus permit a long-term view of options and their consequences, in addition to programming and budgeting in the medium- and near-term. Performance measures and targets are critical to asset management applications in policy formulation, public outreach, planning, programming, budgeting, resource allocation, program and service delivery, operations and maintenance, transportation system monitoring, and assessment of needed updates in policies and priorities. *NCHRP Report 551* tabulates examples of performance measures in use by state DOTs and summarizes previous work on performance measurement, as well as prescribing a method for target-setting.

Ultimately, performance measures are used for many purposes in state DOT, including the following:

- Provide a foundation for policy formulation and systemwide planning.
- Issue a report card: "How are we doing?"
- Track progress towards public and explicitly stated policy goals and agency priorities.

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[3]Cambridge Systematics, Inc., PB Consult, Inc., and Texas Transportation Institute. *NCHRP Report 551: Performance Measures and Targets for Transportation Asset Management.* TRB, National Research Council, Washington, D.C., 2006.

- Support investment decision-making in resource allocation, performance-driven investment decisions, formalized performance-based budgeting, and strengthened internal program management.
- Provide the basis for quantification of program benefits and other impacts as part of investment decision-making, analysis of tradeoffs, and communication to stakeholders in support of program investments.
- Demonstrate accountability and responsiveness to stakeholders, ensuring "wise use of tax dollars."
- Assess the status of a program, evaluating its cost- and performance-effectiveness.
- Meet or respond to Federal and state legislative mandates and reporting requirements.
- Guide improvement of delivery of services, focusing on desirable outcomes and alternative methods of delivering these results.
- Engage an agency within a comprehensive, statewide performance initiative aimed at broad-based improvement in government delivery of services and accountability.
- Improve communication within the agency itself as well as with transportation system users, political leaders, other stakeholders, and the public at large.

While many DOTs and their state governments apply one or more of these aspects of performance-based management, only some apply PBRA specifically, including target-setting.

CHAPTER 3

Performance Targets

3.1 The Role of Targets in Performance-Based Resource Allocation

Introduction

Performance management is a business process that links organization goals and objectives to resources and results. Performance measures and their corresponding targets are the lynchpin in the process. They provide the direct link between the stated goals of an agency and the effectiveness of its investment decisions in reaching those goals. Performance measures, used along with well-defined and well-communicated targets, provide transparency and clarity to the resource allocation decision-making process. Targets provide the critical *context* for evaluating the effectiveness of investment decisions. For example, a performance measure will define how an investment decision will be evaluated in terms of its impact, in absolute terms; in fact, performance measures are often referred to as evaluation criteria. The corresponding target provides the perspective for evaluating the impact of the investment decision *in relation to* the desired end-state, i.e., how significant is a particular investment in helping an agency attain a particular goal. Targets provide the means in which the relative effectiveness of a particular investment decision can be clearly communicated.

Because targets play such an important role in PBRA, this study focused on the factors that influence target selection and the approaches by which targets are actually established. Towards that end, the case studies included validation of the seven-step process for setting targets found in *NCHRP Report 551*. The steps are as follows:

- **Step 1—Define Contexts and Time Horizons.** This initial step involves developing explicit statements about how targets will be used and what time horizons they will cover.

- **Step 2—Select Scope of Measures for Targets.** This step involves identifying the performance measures that are suitable for target development. Some measures may not lend themselves to quantitative targets; others may not have sufficient baseline or trend information available for the agency to be comfortable with establishing a target.

- **Step 3—Develop Long-Term Goals.** A distinction is made between long-term goals about desirable performance levels and short-term targets that represent the best that can be done given resources.

- **Step 4—Consider Funding Availability.** This step involves creating realistic estimates of future resources that can be used as the basis for financially constrained performance targets.

- **Step 5—Analyze Resource Allocation Scenarios and Tradeoffs.** The performance implications of different resource allocations are analyzed both within and across program categories. Use of analytic tools that project future performance as a function of investment level is fundamental to this activity.

- **Step 6—Consider Policy and Public Input.** The process is supported by two-way communication between the agency which provides easily understandable information about the implications of different resource levels and stakeholders providing their feedback on desired performance levels and priorities across different measures.

- **Step 7—Establish Targets and Track Progress.** This final step involves selecting target values for performance measures and putting the procedures in place to track progress towards achievement of targets.

While these basic steps were validated by many of the case studies, the actual use of the steps varied among organizations. In addition, several factors used in setting targets, which are discussed in the next chapter, need to be explicitly linked to the seven steps. This linkage is made in Volume II—Guide for Target-Setting and Data Management.

Public Sector Experience

As evidenced by many of the case study results summarized in this report, the use of specific targets by agencies using PBRA is still somewhat limited. When it does exist, not all of the steps listed in the previous section are taken as part of the process. The robustness of the approach is largely dependent on the following:

- The method used to develop targets—internally developed by agency staff or developed via stakeholder outreach/planning team consensus process;
- Amount of time available for planning a comprehensive performance-based approach—the more time available, the greater chance an agency has to think through each of the steps defined in the previous section; and
- Support by management for agency staff to conduct the exercise and analyses needed to support a well-thought-out performance-based approach.

For transportation agencies at the state, regional, and local level, target-setting is most often seen in relation to asset management systems (e.g., bridge and pavement) where a strong data resource is available for infrastructure condition, collected by almost all state DOTs and local jurisdictions over the last 10 years, in part because of Governmental Accounting Standards Board Statement 34 (GASB34). The amount of data resulting from the GASB34 financial reporting requirements has reinforced performance-based infrastructure management processes and has provided a strong foundation for understanding the relative impact of various resource allocation levels on infrastructure condition over the years. This, in turn, has enabled a strong analytic process in which trends can be reasonably extrapolated into the future and meaningful performance targets can be set.

For many agencies reviewed, the PBRA process involves allocating resources based on how well each potential investment performs in relation to other potential investments, or in a more general sense, whether it provides a positive or negative impact in relation to one or more evaluation criteria. This is often the case, as opposed to evaluating the performance of an investment in relation to a more discrete target. More often than not, this is due to the financial and staffing resource constraints that most transportation agencies are under, which impact the following:

- The ability to collect the data needed to track progress toward meeting targets;
- The ability to develop new technical tools to project future performance as a function of varying levels of investment; and

- The need to avoid setting and communicating to the public and transportation stakeholders unattainable targets, in light of significant financial constraints.

Where the data and the technical resources exist, transportation agencies are using targets as a way to measure the effectiveness of particular investment decisions, in relation to transportation goals, most often as a means to support additional funding for a particular investment type or program, or to justify the cost of investments already programmed for funding. In this sense, target-setting becomes a strong accounting tool for decision-making authorities.

Several of the state case studies provide excellent examples of the role that performance measure targets play in PBRA, especially the selection of projects for the state highway construction program. The Minnesota DOT (Mn/DOT) case study, however, provides one of the best examples because that agency has done the following:

- Recently updated its 2003 statewide performance-based transportation plan; the 2009 version contains changes in performance measures and targets which not only illustrate the evolution of performance management but also provide an example of the significant funding infusion states need to meet their performance targets;
- Implemented performance management during three separate administrations;
- Developed an annual "Snapshot" which compares actual performance goals to targets;
- Adopted a performance-based formula for distributing state and Federal highway construction funding to its district offices; and
- Secured new state funding by describing highway system needs within the context of a performance management framework that sets targets for most of its performance measures.

After completion of the 2003 Statewide Transportation Plan, Mn/DOT integrated PBRA into its highway planning, programming, and project development process. Each year every Mn/DOT district, following uniform guidance, identifies investment priorities. These priorities are based on quantifiable performance measures and targets that establish an impartial statewide basis for identifying critical transportation improvements for the entire trunk highway system. This process, first identified in 2003 and refined over the last 5 years, is illustrated in Figure 3.1.

This five-step investment process, described in the 2009 Statewide Transportation Plan, provides the framework and guidance for developing Mn/DOT district 20-Year highway investment plans. These 20-year investment plans, newly updated in 2009, provide the link between the policies and

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Step 1	Step 2	Step 3	Step 4	Step 5
Identify Investment Needs	Project Future Revenues	Set Investment Goals	Develop Investment Plan	Prioritize Unfunded Investment Needs
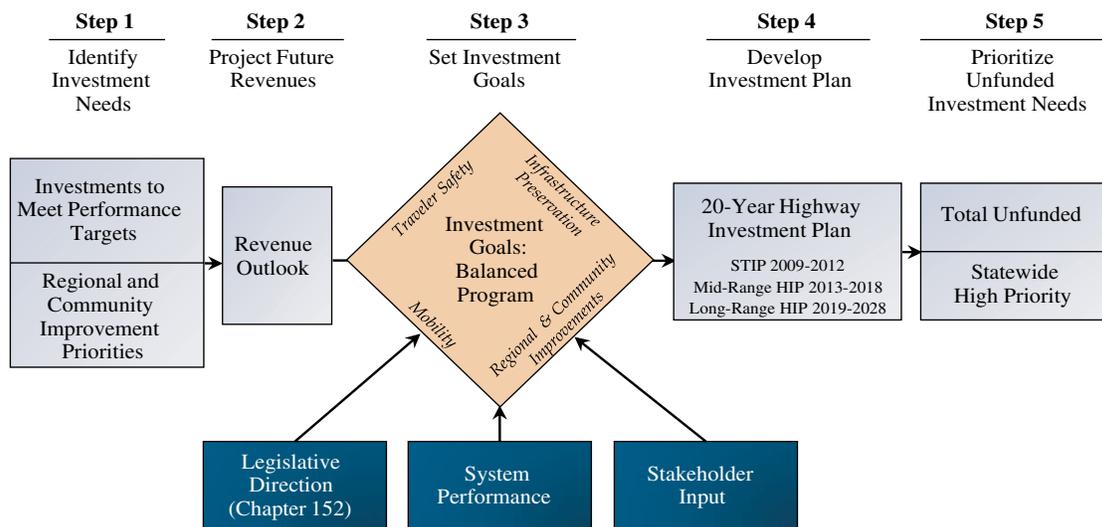
Figure 3.1. Mn/DOT highway investment plan development process.

strategies established in the Statewide Plan and the capital improvements that are made to the State highway system. Together, the eight district plans constitute a State 20-Year Highway Investment Plan for 2009–2028. The plans were developed in accordance with the following five steps which are described in detail in the case study write-up in Volume III and which differ from the seven steps in *NCHRP Report 551*.

Step 1—Identification of Investment Needs. Investment needs fall into two categories: improvements to address system performance and improvements to address regional or community priorities. Performance-based needs include investments to meet established system performance targets related to traveler safety, infrastructure preservation, interregional corridor mobility, Twin Cities mobility, and Greater Minnesota urban mobility. The analytical models and methodologies used to calculate the investments to meet these system performance targets are described more fully in the District Plan Summary section of the Statewide Transportation Plan. Regional priorities include a wide range of highway improvements to support local business or community development goals, from major highway expansions and new interchanges to intersection modifications, trails, and sidewalks. These regional priorities ($3 billion to $5 billion) illustrate the fact that there are many demands on available transportation funding beyond the investments needed to meet established statewide performance targets ($62 billion) in the next 20 years.

Step 2—Project Future Revenue. Next, revenues were projected based on the trends in state and Federal revenue sources for state highway construction. No new sources of revenue were assumed but the increased bond funding for trunk highways enacted by the 2008 Legislature was factored into the projection. Construction cost trends also were analyzed and

projected so that investment needs and expenditures could be estimated in year-of-construction dollars. A more complete description of revenue and cost trends and projections is provided in Chapter 5 of the Statewide Transportation Plan. Given the volatility in both costs and revenues and the current discussion of increased Federal infrastructure funding as an economic stimulus package, the projections assumed in the new plan represent a snapshot in time and will need to be updated annually as long-range investments become programmed in the four-year State Transportation Improvement Program.

Step 3—Set Goals: A Balanced Program of Investments. The investment priorities reflected in the 2009 update of the District Plans differ significantly from the 2004 plans. At that time, Mn/DOT identified infrastructure preservation as its top priority, and districts were directed to fully fund preservation needs before other priorities, including safety, mobility, and local community priorities. The revenue and costs outlook in 2004 projected sufficient long-term funding to meet not only preservation needs but other areas of need as well.

Between 2004 and 2008, revenues have not grown as anticipated, and construction costs have increased dramatically. Even with the increased transportation revenues provided through Minnesota law 2008, Chapter 152, the costs to fully preserve bridges, pavements, and other roadway infrastructure during the next 20 years will exceed projected funding.

The investment goals for the 2009 district plans reflect Chapter 152 legislative direction, consideration of system performance trends and stakeholder input. While infrastructure preservation continues to be an important priority for Mn/DOT, it cannot be the exclusive priority. The goal for the 2009 District Plan updates is to lay out a balanced program of investments that achieves three objectives:

1. Supports the continued development of the statewide economy and livability of Minnesota communities;
2. Represents the optimum allocation of projected revenues among the four strategic investment priorities of safety, mobility, infrastructure preservation, and regional and community improvements; and
3. Results in a consistent level of investment effort across districts towards statewide system performance targets, including the investment directions established in Chapter 152 for the rehabilitation or replacement of fracture critical and structurally deficient bridges and other highway improvements.

Step 4—Develop Investment Plan. Given the needs, projected revenues and investment goals, each district developed investment plans for 2009–2028. The investment plans are divided into three timeframes: 2009–2012 STIP (State Transportation Improvement Program), 2013–2018 HIP (Mid-Range Highway Improvement Plan), and 2019–2028 LRP (Long-Range Highway Investment Plan). Investments identified for the STIP include projects that have developed scopes and cost estimates. Investments identified for the HIP represent very preliminary cost estimates subject to change as projects are developed. The Long-Range Plan investments in the second 10 years represent general estimated investment levels in various improvement categories. The case study contains a table that summaries investment needs by strategic investment priority and planning period.

Step 5—Prioritize Unfunded Needs. With a total estimated investment need exceeding $65 billion during the next 20 years and projected revenues of about $15 billion, Mn/DOT's analysis indicates that almost $50 billion remains in "unmet needs" in present dollar value. To place this level of funding in perspective, every 5 cents on the motor vehicle fuel tax in Minnesota provides just under $100 million per year to the State Road Construction fund. To generate an additional $2.5 billion in revenue over 10 years would require the equivalent of a 12.5-cent increase in the state gas tax.

The 2009 plan fully acknowledges that future transportation funding will never be increased to meet this degree of "unmet need." The plan's policies and strategies, therefore, emphasize a new approach to meeting system improvement needs through stronger partnerships and innovation. This is especially evident in the plan's vision for mobility in the Twin Cities, calling for more comprehensive and fiscally realistic approach to congestion mitigation.

The plan also stresses the need to set priorities. Towards this end, Mn/DOT has identified five percent of the "unmet needs" as high-priority investment options should additional revenue be available during the next 10 years. Additional funding, such as a Federal economic stimulus bill, would likely carry specific eligibility criteria or investment direction. For this reason, the identified high-priority unfunded investments are distributed across all four strategic investment categories.

Private Sector Experience

Institutional Context for Private Sector Decision-Making

Private and public sector goals are analogous in the sense that in both cases, a strategy drives decisions about organization and processes. Organization and process decisions, in turn, drive a need for resources and help set targets. Finally, the gap between performance and the agreed targets is the ultimate basis for re-allocation of resources.

Private companies set up transportation as either a profit center, a cost center, or a service center. This form of organization drives the overall policy goals and objectives. A profit center would focus on maximizing profit. A cost center would focus on minimizing cost. A service center would focus on maximizing service.

Acquisition, operation, and maintenance processes are organized to support the overriding goals and objectives. Acquisition, often of fleets and terminal equipment, is organized to achieve targets such as return on investment, operating cost, and/or expansion. Transportation companies measure and use return on investment in order to decide whether to buy new equipment, build new hubs, or upgrade systems. Operational processes are geared to meeting either cost or service targets or both. Maintenance processes are usually geared to lowering operating costs. Private sector transportation companies use the Operating Ratio (operating expenses divided by sales) as a primary measure of performance. Underneath this and other profitability metrics, private sector companies almost universally track operating metrics such as on-time arrivals and departures and root causes of delays.

Information Technology (IT) processes are geared to support operational processes and usually need to meet return on investment criteria. Radio frequency identification (RFID), Global Positioning Systems (GPS), Transportation Management Systems (TMS), fleet equipment, and terminals need to support the overall mission of the organization.

Environmental regulations regarding noise, air, and water pollution constitute a minimum threshold for the allocation of resources, but private sector companies generally have a relatively ill-defined approach for setting resource allocation decisions to meet social or environmental commitments. Seven approaches provide some insight into the wide range of approaches in current practice, which include: compliance with mandatory regulatory standards; compliance with voluntary industry standards; subjective evaluation; using last year's performance as a benchmark; quotas; linkage to a profit-oriented goal; and increases in brand equity. Industry standards such as ISO 14001 offer companies benchmarks and standards

for environmental stewardship. Subjective approaches can reward social or environmental awareness but rarely commit to any consistent or documented standard. This approach can be very motivational if the evaluation is positive, but it is subject to review, revision, and even reversal depending on the manager in charge. As with charitable giving, many private sector companies use last year's contributions as a benchmark for next year's level of resources allocation. Following the model of minority hiring, where performance is measured as a percent of sales dollars, some companies target earning or spending a certain percentage of their sales dollars on social or political contributions. Many companies strive to find overlap between social and economic goals. The underlying premise is that the elimination of waste is consistent with cost reduction. Therefore, "green" goals also are coincidentally profit-increasing. Finally, some companies participate in socially responsible spending because it increases their brand equity. Brand equity is frequently measured at large private sector companies, whether they are in consumer products or in transportation. For example, the brand equity that can be gained by emphasizing that rail transport is "greener" than road haulage

can measurably increase the shareholder value and the market penetration of a railroad.

Also, there may be a difference between the way the private and public sector DOTs disburse funds, which may result in a difference in the method and the timing of data collection and aggregation and in the timing of allocation of resources. Private sector funds are budgeted in one cycle and released in another. Expenses are released via use of a purchasing card (p-card) or purchase orders (PO). Public sector funds may operate on a different release schedule than private sector.

Corporate Planning and Control Processes

PBRA is part of a broader corporate planning and control process. This process has four components: strategy, planning, execution, and control and feedback (Figure 3.2). Each component consists of the following subprocesses:

- The Strategy-setting process consists of having a mission, understanding the competitive landscape, and developing a strategy to be successful in that competitive environment.
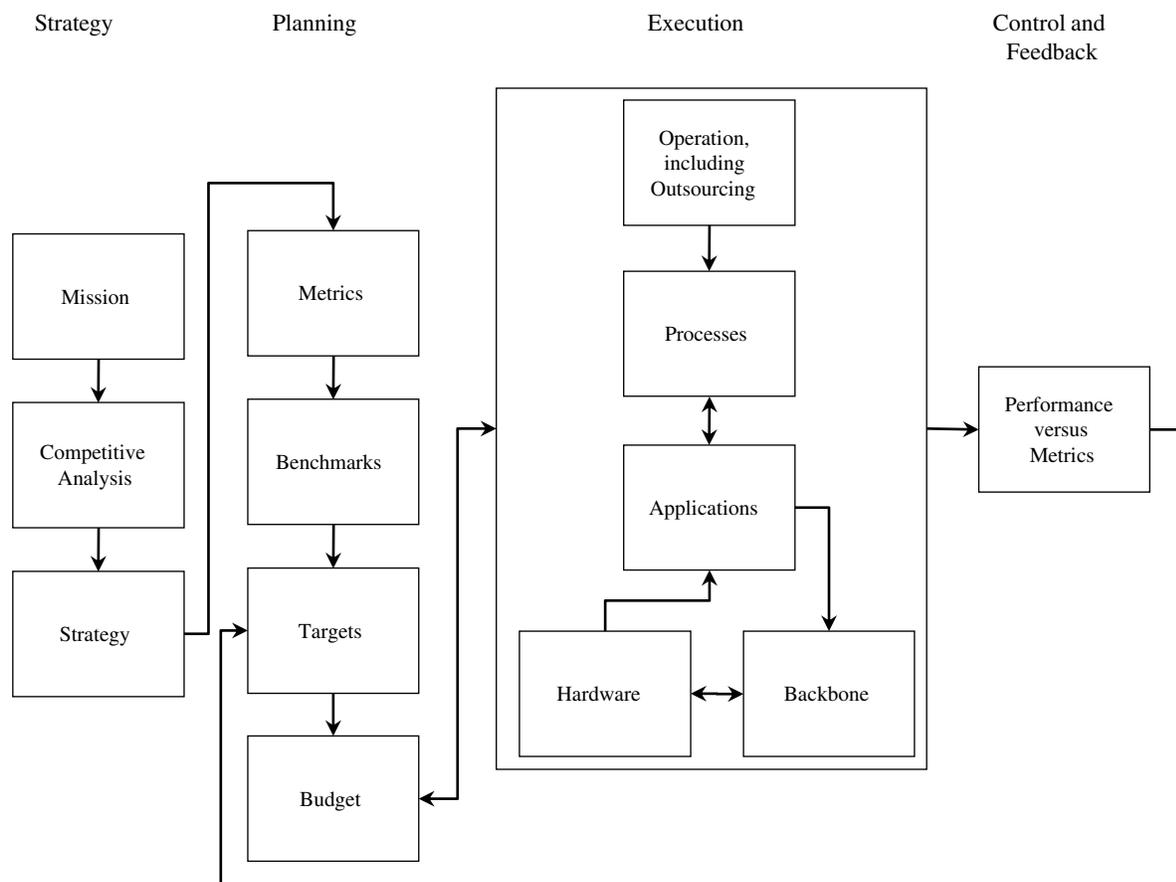
Source: Boston Strategies International.

Figure 3.2. Corporate planning and control process.

- The Planning process consists of agreeing on or developing metrics that help track and sometimes predict success by referencing benchmarks from competitors or best-in-class companies that represent the state of the art in a given function or process (for example, transportation management).
- The Execution process includes organization, process management, and information architecture. The organization structure includes a determination of which activities to outsource and which to perform in-house. Process management includes the definition of key business processes and codified sequences of activities. The IT architecture determines the way in which information supports and/or shapes the organization and the processes.
- The Control and Feedback process can consist of many management controls, but the primary instruments are the annual budget and cost accounting. When the feedback is good, the budget usually increases. When the feedback is bad, the budget usually decreases.

Evolution and Current State of PBRA in Private Sector Companies

The history and evolution of performance-based management is deep and rich at most private sector companies. Private sector companies have had metrics in place for as long as most senior managers have been at their companies, which in many cases is over a dozen years.

The key incentive for achieving individual objectives is compensation. Another key incentive is the motivation gained from competing among business units in the same company and winning.

That being said, not all private sector companies practice all five elements of the PBRA model. While the vast majority of companies have goals and track performance data, many do not set targets and many do not have explicit feedback mechanisms to allocate resources based on varying levels of performance. Here is how the five elements of the PBRA model often play out at major private sector companies:

- **Goal Setting.** Goal-setting is typically initiated by the CEO and his or her top-level advisors such as the CFO. These flow to business unit heads and then on to operational staff. The goals are often, or are driven by, top-level financial imperatives. These often seem arbitrary to people below the senior management level, who can perceive the goal as indirect or imprecise.
- **Metrics.** Nearly every private sector company chooses metrics to track. These can be either financial or operational, or a combination of the two. The historical legacy of the metric is as important as the precision with which it addresses the desired outcome. Organizations learn to interpret measurements over time, and if they are imprecise, they apply subjective judgment to the metric. Sometimes companies use the same metrics as their competitors, or as "best-in-class" companies, so they can compare levels of performance through benchmarking.
- **Targets.** The prevalent practice in the private sector is to foster competition amongst business units so a natural target evolves. An alternative is to set the target according to what other companies achieve. Using external benchmarks requires careful consideration of the similarity of the reference organization to one's own, as well as to ensure that both companies are computing the metric the same way.
- **Resource Allocation.** Most private sector companies set individual compensation to vary according to the degree to which they reach the target. Other common mechanisms for allocating resources are the annual budgeting process and the capital expenditure authorization process.
- **Results Monitoring.** Private sector companies invariably gather operational and financial data from the Enterprise Resource Planning (ERP) or legacy information systems, and make it accessible to users. Some make it easier than others. Some companies post the results to their intranet and have drill-down query capabilities, while others make users request reports from IT. As users' computer skills increase and systems become more accessible and menu-driven, results are being monitored by a larger proportion of employees. This democratization of data is enhancing the ability to reach the target.

Goals are often prioritized using the Keep It Simple, Stupid (KISS) Principle. They prefer one or two universally recognized goals to a dashboard of nuanced goals. Some companies, however, have a simple and intuitive hierarchy—safety, then financial results, then operational excellence.

Targets are set on an annual basis in most private sector companies, and these are valid for one year. Although senior managers and the Finance department usually have long-range goals, most targets are set and performance monitored on an annual basis. To link individual performance to long-term goals, companies sometimes use equity as an incentive for employees rather than to share multiple annual targets with them.

In the private sector, most companies' processes operate such that every goal should have a target and every target should align with a goal, at least according to the companies interviewed for this study. Alignment of metrics and goals is so important that most companies prefer to reduce the number of goals and targets rather than risk misalignment or confusion between goals and targets. Again, this reverts to what is a recurring theme of simplicity as an underpinning principle of performance measurement and management.

Realistic goals are essential to making rewards and penalties effective. While "stretch targets" used to be common,

most companies have diverged from this approach. They now set goals that they believe can be realistically attained within the year. With realistic targets, the anticipated gains can be embedded in business unit or departmental budgets, and individuals can be more readily held accountable for their performance towards reaching the target. On the other hand, complex, confusing, or overly aggressive targets can be used as excuses for non-performance.

The most common consequence of failure to meet targets is a less-than-favorable compensation review. This may or may not be coordinated with a performance improvement initiative at either the individual or the group or departmental level. Job loss also is a possible consequence of a failure to hit targets.

3.2 Factors Influencing Target-Setting

Public Sector Experience

There are multiple factors that lend themselves to the development of a PBRA process within transportation agencies. These factors include such things as strong agency leadership and crisis situations (e.g., funding shortages or public concerns) that focus attention on agency decision-making processes, and others. These factors have been well documented over the last two decades in performance-based literature. This section focuses on factors most important to **target-setting** as an element of performance-based planning. Target-setting is a critical, yet often under-utilized aspect of PBRA. The factors influencing target-setting, which emerged repeatedly from the case studies developed as part of this study in Volume III, are summarized in the following section.

Political/Legislative Influence

Perhaps the most immediate and direct factor influencing target-setting as an element of PBRA is the existence of a commission or other political body to which a transportation agency must report the performance of investment decisions. Political intervention in the process may result from controversy, as seen in states such as Florida, Virginia, and Ohio that have said candidly that legislative criticism over project delivery and fiscal forecasting compelled expansion of performance targets and accountability, or the increasing public outcry over transportation services that force political attention on an issue, as is the case in Atlanta, GA, where increasing congestion issues led the Governor to establish a congestion task force which ultimately recommended a congestion reduction target for the region.

While political influence of this direct manner can have very complicated repercussions, it has shown to be one of the most positive indicators for implementation of target-setting. For almost every agency reviewed that is using targets as part of their PBRA process, political or legislative intervention provided the initial impetus for establishing discrete targets. Political intervention can be triggered by a number of issues, but the most common is the increasing limitation of transportation funding at all levels of government, which has created more competition for available funds and also made it more important to justify funding requests.

Depending on the nature of the political influence, elected officials or legislators may direct agencies to develop a more objective process that includes measures and targets, as was the case in Minnesota, as a result of the Minnesota Legislature and Department of Finance requirement that agencies use performance measures in biennial budget documents. It was also the case in Washington State, in which the State's Legislative Transportation Committee initiated a study in 1991 which resulted in recommendations for a PBRA process which is still in place, having been refined and improved over the last two decades. Political bodies may also establish targets themselves, as seen in California which legislated CO_2 reduction targets that the Metropolitan Transportation Commission (MTC) has been addressing as part of its recent regional transportation planning activities or in Atlanta where the Governor's Congestion Mitigation Task Force resulted in a recommendation that a travel time index target of 1.35[4] be adopted for the region.

The latter situation, in which political bodies develop targets themselves, can be difficult to negotiate, if the process is not properly informed by knowledgeable transportation staff who will guide the development of reasonable, attainable targets. While political involvement can be challenging, it also can provide transportation staff the support they need to select projects that are proven to improve performance and therefore should be a priority for funding. This can often be a difficult situation for agency staff, working within any scale of government, that operate within a highly political arena where pressures to fund certain projects, regardless of merit (in relation to stated transportation goals), can be intense.

Customer Service Focus

Those agencies that have taken a clear customer-service approach to transportation planning, management, and design understand the need to use targets to be able to communicate to the system user—the "customer." Customer satisfaction is a fundamental aspect of performance for these organizations.

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[4]The Travel Time Index (TTI) is the ratio of travel time in the peak period to travel time in free flow conditions (speed limit). For example, a TTI of 1.35 indicates a trip that takes 20 minutes in free flow conditions would take 27 minutes in the peak (35 percent longer). The TTI can be used as a performance measure to track changes in the regional transportation network and to regularly report to the public progress being made in improvement of the operation of the network.

They break down and analyze customer satisfaction or dissatisfaction from broad perspectives that address issues in areas such as social and community impacts and environmental impacts of transportation investments, and in more narrow terms that address issues related to daily personal travel needs.

Coral Springs, Florida, provides a very strong example of a municipality that has taken a very direct customer-service approach towards its resource investment process, in which customer input drives the decision-making process. Target-setting is a key component of the Coral Springs process as it provides a direct translation of progress, as feedback for a community that has been actively engaged and empowered as part of the planning process.

The Coral Springs focus on customer satisfaction is perhaps the most important factor influencing target-setting, which can be seen most clearly in the private sector examples. As indicated in the ABC Logistics case study, customer service is the overriding objective in its resource allocation process, and its entire process is geared towards customer satisfaction. ABC Logistics exhibits all five elements of PBRA, including target-setting. Each defined goal has a target, with targets stemming from the promises made to its customers in their contracts with the logistics company. A Customer Care program monitors the company's performance relative to the targets and customer expectations, with a feedback mechanism to communicate results to the public and to link individual employee performance (and merit) to the performance of the company. Additional factors influencing target-setting in the private sector are described in the following section on "Private Sector Experience."

PBRA History/Evolution in State of the Practice

Another key factor in target-setting is an agency's performance management history. Agencies that are only at the beginning of implementing a performance-based process generally have less complete and less sophisticated target-setting processes. In general, there is a typical evolutionary path that agencies follow. A corollary to this evolution is the emergence of an agency's data sophistication.

Agencies with a history of PBRA, including target-setting, provided the following insight into how best to incorporate target-setting into the PBRA process:

- "Keep it simple!" Agencies that have a history with performance-based planning and application of targets in the resource allocation process understand the need to keep the target-setting aspect relatively simple and easy to understand. When adding the target-setting dimension to the PBRA process, it could easily become a much more difficult system to manage. However, if measures and their attendant targets are kept focused and straightforward and

are communicated in terms that decision-makers and the public understand, they become useful tools. Keeping it simple can be viewed from the following perspectives:
  - Keep the measures and the targets simple. Do not make performance measurement an academic exercise; measure what is important, do not measure everything. Too many measures and targets, with their own data systems and evaluation procedures, can create a cumbersome and unsustainable situation in which an agency is data rich but information poor.
  - Communicate performance in terms that are readily understood. Communicating targets in a manner that makes sense to the general public seems to be a strong indicator for the success of PBRA and the integration of target-setting.
  - This principle is exemplified by a number of agencies, including ARDEC, which tracks performance in 16 different areas on stoplight charts with red, yellow, and green indicators; the City of Coral Springs, FL, which "rolls up" an extensive series of performance measures into 10 key composite measures, referred to as the city's Stock Index, that summarize city performance at a glance; and Hennepin County, MN, which uses a Balanced Scorecard approach in which numerous measures are evaluated and tracked in terms of multiple perspectives (customer, finance, internal process, learning and growth) and simplified into tables of information providing "warning lights" for areas in need of improvement. The "keep it simple" principle is particularly strong in the private sector.
- Integrate performance measurement into daily agency practice. This directs attention to key issues, promotes financial resources, and provides the ability to develop stronger PBRA systems. Some of the agencies reviewed have tied performance of investments to staff-level performance, though it is more common among the private sector cases. The agencies have shown the importance of making sure that each staff person understands his/her contribution to the mission, and that the level of contribution should be part of the staff review process. They have learned to "manage by the measures."
- Start now. Agencies with mature PBRA systems indicate that the only way to have a "PBRA History" and begin the evolutionary process is to get started with PBRA and target-setting and learn by doing.

Mn/DOT's measures and targets, identified in its 2003 Statewide Long-Range Plan, were refined through application. As a consequence, the following PBRA-related changes were made in the new 2009 long-range plan:

- Expanded safety measures by stratifying different modal and vehicle type of fatalities;

- Eliminated most of the land use measures;
- Added access to intercity bus service, air service, and airports;
- Added transit ridership;
- Added Congestion in Regional Trade Centers, Public Transit Service Hours, Transit Coverage, and nonauto commuter trips; and
- Added air pollutants, cleaner fuel, and wetland impacts.

MTC's performance-based process also has been evolutionary during the development of its last three long-range plans. Numerous advances in introducing a performance-based framework were made even within the last year of developing the most recent RTP and have contributed to the development of more meaningful targets for that agency.

Washington State DOT's (WSDOT's) experience also confirms that target-setting requires a solid history of performance data as well as managerial comprehension and appreciation of that data, which comes with time and experience. Managers must have the ability to understand transportation system behavior—i.e., "what the data are saying"—and to discern what they can or cannot control.

Commitment to Regular Communication and Reporting

Regular tracking of investment performance and reporting of results to the public and transportation stakeholders serves to focus attention on an issue over time so that it is not lost in political and public discourse as new challenges arise. Regular reporting and communication of progress helps to keep staff and the public focused on the particular challenge, especially when it is tied to agency or even staff-level "merit"/compensation. This helps all involved to understand the nature of solving process problems over the long term, rather than focusing on immediate issues (e.g., fighting fires) that often distract from the larger mission of an agency. It also supports longer term trend development that is needed to track the performance of investments over time.

Regular reporting of performance results is a commitment common to all organizations interviewed. This occurs both internally and externally for public sector organizations, and usually just internally for private sector organizations. The following examples illustrate how some agencies support the democratization (i.e., widespread access) of data within the agency, as previously discussed in *Results Monitoring.* For example, the Orlando/Orange County Expressway Authority (OOCEA) publishes a monthly report entitled "Expressway Travel Time Performance" which documents the morning and evening peak travel times per lane on the designated roads which are under the operation of OOCEA. This report is critical to the OOCEA as a "performance management" tool to assess the effectiveness of managing the travel time for the

public on the toll system. The report, as well as weekly data for each plaza, also can be used to determine when and where to add staff at toll stations in order to keep traffic moving safely through the expressway system. Other resource allocation decisions resulting from these data include budget adjustments and capital project prioritization and scheduling.

Japan's Ministry of Land, Infrastructure, and Transport (MLIT) management framework incorporates four key steps, the third of which is to "evaluate achievement levels." Through this process, the Road Bureau uses performance measures to prioritize roadway projects within program areas based on reported results and progress towards annual and 5-year targets (Figure 3.3). The Bureau submits a required report, which compares performance to funding, to the Ministry of Finance when the MLIT requests funding, though funding to the Bureau is not tied to the reported performance. For the MLIT, as with the OOCEA, these reporting mechanisms with progress towards targets aid in interfacing with the public and stakeholders and also guide internal decision-making. If MLIT targets are not met for a program, for instance, then a closer review is done to determine how the processes for that program may need to be revised, or if a new program may need to be developed to address those performance needs. Conversely, if targets are consistently met earlier than anticipated, target deadlines or measures are reset to reflect more accurate expectations.

Each year since 1994 Hennepin County has produced a Community Indicators report that provides a view of the current community conditions and trends based on selected quantitative data. The report is a reflection of the health of the county as a whole. Over time, indicators have been adjusted and updated to reflect the county's changing interests and priorities. However, many of the original indicators have been retained in order to establish a trend line and track changes in residents' quality of life. In 2002, Hennepin County government introduced a strategic management framework that focuses on results and customers. Consistent with the framework, the indicators in each annual report have been grouped to align with the county's current overarching goals. The regular development of these "products" that are distributed to the public and used by decision-makers helps to maintain staff enthusiasm for the performance-based process and ensures the continued development of the necessary inputs for the report.

Span of Control/Agency Jurisdiction

Traditionally, transportation performance measures have been used to gauge the impacts of discrete types of investment strategies in relation to very specific transportation goals, with goals most often tied to a modal aspect of the transportation system, fund source for the transportation investment, or particular transportation function within a particular geography (local, regional, state). This has led to a somewhat

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Policy Theme	Indicators		FY2002 (Base Value)	FY2006		FY2007	
				Actual Result	Target	Estimate	Planned Target
Strengthening of international competitiveness	①	Ratio of hub airports and ports accessible within 10 minutes from an IC of expressway	59%	67%	67%	68%	68%
Regional self-reliance and strengthening of competitiveness	②	Time loss due to traffic congestion	3.81 billion people-hr/yr	3.31 billion people-hr/yr	Approx.10% decrease (Approx.3.43 billion people-hr/yr)	Approx.3.24 billion people-hr/yr	Approx.10% decrease
	③	Hours of roadwork	201 hr·km·yr	123 hr·km·yr	16% reduction from FY2002 level	114 hr·km·yr	Approx.20% reduction from FY2002 (161 hr/km·yr)
	④	Ratio of main cities in neighboring regions that are connected to each other by an upgraded national road	72%	75%	76%	77%	77%
	⑤	Percentage of people who are able to have a safe and pleasant drive into the city (center of daily life) in under 30 minutes	63%	66%	67%	68%	68%
	⑥	Percentage of intersections with information signs having route numbers and route names	—	71%	78%	80%	90%
Securing safety, assurance	⑦	Percentage of cities that have rescue routes covering a wide area in the event of disaster	66%	76%	74%	80%	76%
	⑧	Percentage of "urban areas having disaster prevention issues"	37.0%	33.9%	33.0%	33.2%	32.0%
	⑨	Road traffic accident casualty rate	118.4 accidents/100 million vehicles/km	115.3 accidents/100 million vehicles/km (provisional)	Approx.110 accidents /100 million vehicles/km	Approx.10% reduction (108 accidents/100 million vehicles/km)	Approx.10% reduction (108 accidents/100 million vehicles/km)
	⑩	Percentage of perpetually closed crossings at which prompt measures have been taken	—	21%	32%	40%	100% (target for FY 2010)
		Time loss due to closed railroad crossings	1.366 million people-hr/day (actual result for FY2004)	—	—	—	1.3 million people-hr/day (target for FY2009)
Creation of affluent living environment	⑪	Reduction of CO2 emission from motor vehicles	—	Approx.1.1 million tons of CO2/yr	—		Reduction to approx.8 million tons of CO2/yr in FY2010
	⑫	Percentage of barrier-free main roads in the vicinity of passenger facilities with an average daily user volume of more than 5,000	Approx.17%	Approx.44%	Approx.42%	Approx.50%	Approx.50%
	⑬	Percentage of trunk roads in urban areas without telephone poles	7%	Approx.12% (quick report value)	Approx.13%	Approx.15%	Approx.15%
	⑭	Achievement rate of required limits on nighttime noise	61%	73%	72%	Approx.80%	72%
	⑮	Rate of NO2 environmental goal achievement	—	73%	85%	Approx.90%	Approx.90%
		Rate of SPM environmental goal achievement	—	91%	100%	100%	100%
Service life extension of existing stock	⑯	Ratio of bridges receiving preventative maintenance	—	95%	96%	Approx.100%	Approx.100%
		Road structure maintenance ratio — Bridge	86%	80%	91%	83%	93%
		Road structure maintenance ratio — Pavement	91%	95%	91% (Unchanged from FY2002 level)	93%	91% (Unchanged from FY2002 level)
Effective utilization and functional augmentation of High-way network	⑰	Ratio of high-standard roads usage (targeted traffic volume for conversion to high-standard roads)	13.1%	14.4%	14.5%	15.0%	15.0%
	⑱	ETC usage ratio — Nationwide	5%	72% (Spring 2007)※	75% (Spring 2007)	Approx.80% (Spring 2008)	Approx.80% (Spring 2008)
		ETC usage ratio — Metropolitan Expressway	6%	78% (Spring 2007)※	90% (Spring 2007)	—	85% (Spring 2008)
		ETC usage ratio — Hanshin Expressway	3%	72% (Spring 2007)※	90% (Spring 2007)	—	85% (Spring 2008)
Execution of road measure	⑲	Ratio of comprehensive cost reduction of road projects	—	12% decrease (quick report value) from FY2002 costs	Approx.12% decrease from FY2002 costs	Approx.15% decrease from FY2002 costs	Approx.15% decrease from FY2002 costs
	⑳	Level of road user satisfaction	2.6 points	2.9 points	2.9 points	3.0 points	3.0 points
	㉑	Number of website hits	15.46 million hits/yr	69.39 million hits/yr	Approx.81 million hits/yr	Approx.90 million hits/yr	Approx.100 million hits/yr

Source: Road Bureau, MLIT, "Outcome-Based Road Administration Management in Japan."

Figure 3.3. Road bureau performance measure and target report for FY 2006 and 2007.

siloed approach towards performance measurement, with measures that provide a more narrow assessment of investment options as opposed to a "systems"-level perspective. While many transportation organizations have begun to develop more comprehensive performance measures that better reflect their diverse planning goals and objectives, measuring performance over the larger transportation network and across various stages of the transportation planning process remains a challenging endeavor. This topic is being evaluated through NCHRP Project 8-67.

The span of agency control, whether it is through funding, modal authority, or geographic jurisdiction, plays a strong role in the development of measures and targets, because it controls the perspective from which each investment is evaluated. An agency that manages only highways will have a narrower set of measures than does an agency with jurisdiction for multiple modes. States responsible for all roads, rather than only the higher functional classes, face greater data-gathering complexities. This can influence how they set targets and how they use data to measure progress towards those targets. For instance, Mn/DOT has direct control over the quality of pavement, but it can only influence transit service provided in Greater Minnesota through funding. In all instances, the level of influence that the department has over a particular measure affects the target that is eventually set. Within DOTs, standard siloing of functions has led to strong asset management

systems for roadway maintenance functions, but this process has not translated as strongly to other DOT functions.

The emerging authorization debate includes the possibility of Federal performance measures and targets. Targets must be highly sensitive to the differences among states in terms of their data, analysis methodologies, existing funding, PBRA history, and other constraints. This likely will result in very high-level, broad targets. Targets likely need to be tied to incentives or disincentives due to limitations in the Federal government's span of control over the systems being measured. In the case of the Kansas State Department of Education (KSDE), Federal No-Child Left Behind legislation presented Federal targets for the State to achieve, changing the KSDE's role and to some extent changing its span of control within Kansas' educational system. The KSDE ties its own state-level targets, which complement the national targets, to accreditation and limited incentives.

Financial Resources

No constraint or factor in constraining the PBRA process and affecting target-setting is cited as much as financial resources. Financial resources are intimately intertwined with the resource allocation process, both determining an agency's ability to implement such a process by influencing other factors such as technical resources, and also potentially being determined by the process itself.

For example, performance data has played a key role in biennial state legislative budget allocations for Mn/DOT, and it also has played an important role in the debate for new transportation funding. Mn/DOT quantified its highway performance measures and targets in its 2003 State Transportation Plan and concluded that Minnesota was under-investing in its highway program by one billion dollars per year. This performance-based analysis was accepted by the legislature and virtually ended the legislative debate on level of need. The legislative discussion shifted from the question of need to the question of payment.

Similar to the influence of financial resources on target-setting, staffing and person-hours of available time can affect the depth of a PBRA program, including targets that an agency can assemble and monitor.

Timeframe

The timeframe of desired results affects how targets will be set and what they will be. Timeframe is sometimes determined by stakeholder and internal agency needs but also can be dictated by forecasting capabilities.

At Japan's MLIT, annual targets are derived in part from the latest major subjects of policy, planning, and programming to emerge from the funding reports from the MLIT and Road Bureau, the Road Bureau's Mid-term Visioning Report,

and the national government's 5-year Major Infrastructure Development Plan. Longer-term targets (referred to by the Road Bureau as "goals") match this with a 5-year span. The Road Bureau utilizes the funding reports to estimate future funds, assuming that approximately the same amount of money will be available annually for the next five years. This information is used when determining feasible 5-year goals for the Bureau and results in what is essentially a financially constrained target.

The Road Bureau sets and annually updates shorter term annual targets when it prepares its annual Performance Measures Report/Planning Report. At this time, the measures themselves also are reviewed and subsequently modified or new measures are added. This adjustment in the measures themselves may then require an adjustment in the relationship between the targets and the measures. Targets for the next fiscal year are based on the possibility of achievement and similar to the 5-year goals, consider financial constraints.

In Washington, the primary responsibility for translating long-term goals (dictated by elected officials) to short-term or "incremental" goals, objectives, and targets falls to the Department of Transportation, in consultation with executive and legislative members and staffs. This process centers on how to set and describe these incremental milestones, how to communicate them to the public, and what legal liability the State may incur by promoting these short-term targets publicly. WSDOT managers also may consider alternatives and adjustments in the engineering solutions to problems, in the methods of service delivery, and in the construction materials and techniques to be used in order to address these short-term targets. These options help to achieve stated targets within current funding and other resource constraints and thus maintain consistency between short-term program accomplishments and long-term, aspirational goals.

Technical Resources

The presence or lack of forecasting tools can influence greatly the sophistication of forecasted targets. Agencies that have used HERS, PONTIS, and other tools for forecasting the results of long-term programs have greater insight with which to set long-term targets.

Availability of analysis tools to identify performance impacts of projects realistically and efficiently and to track performance in relation to targets will determine what measures and targets can be used. Sometimes agencies develop desired measures and targets, even when data are not yet available, as a means of creating a "wish list" of data sources. Often it is difficult for decision-makers to see the need for data collection for a single performance metric, particularly if it appears to be part of a single endeavor (e.g., a long-range plan); if it is part of a larger,

comprehensive PBRA process, however, it is often easier to justify additional data needs.

The evolution of tools over time makes it very difficult to track progress consistently. Change over time in tools, data, and analysis procedures, as well as differences between agencies and jurisdictions, can make it difficult for stakeholders—and even internal staff—to properly interpret the results. Staff turnover also can exacerbate this situation. Agencies must develop ways of maintaining their institutional knowledge base to properly utilize evolving tools and procedures.

It is often difficult to make the case to senior management or political decision-makers for funding for data and tools. For the MTC, the development and availability of the StreetSaver pavement management tool has greatly aided that MPO with project prioritization and funding distribution among local jurisdictions and has garnered strong buy-in among those communities. It has made this particular asset management program arguably the most data-driven, performance-based process in the MPO's planning process and has allowed for more rational maintenance of the region's highways.

However, the MTC's existing analysis and modeling tools are not equipped for a rigorous performance analysis at the project level for long-range planning, with precision levels lower than desired. It also is difficult to compare performance between modes, or even measuring impacts within non-auto modes, such as capturing benefits from bike networks or transit programs.

Typical technical resources available to organizations as well as the influence of these resources on target-setting are elaborated further in Section 3.3.

Centralized/Decentralized Organization

The organizational structure of an agency affects the structure of that agency's PBRA program and process as well as the development and purpose of targets. WSDOT is a somewhat centralized organization, allowing the central office to work directly with state government and stakeholders to establish targets. It also allows the organization to handle a somewhat complex and involved target-setting process for capital programming, which must account for broad policy goals and objectives, external reporting, and internal programming needs. The target-setting process is coordinated across several other processes, such as WSDOT's long-range planning process (LRP), its biennial Strategic Plan, the Governor's GMAP, the Attainment Report submitted by OFM to the legislature, the Federal Stewardship Report, and the Washington State Quality Award (a Baldrige process).

Conversely, the Florida Department of Transportation (FDOT) is highly decentralized, resulting in possibly different targets for different measures in different districts, but with broader and more flexible measures and targets at the central office. Decentralization means that FDOT's district offices are essentially DOTs themselves, each with its own secretary, with planning, environment, right-of-way, design, construction, maintenance, and legal offices. The various offices within the districts report to the district secretary and not to their counterparts in the central office. The district secretaries report to the Secretary, and also sit on the FDOT Executive Board. Detailed funding allocation decisions are made at the district level, resulting in wide variations in funding priorities and decision-making processes among different districts. This structure requires a strong but flexible performance management system to ensure consistency across districts in terms of achieving statewide goals. FDOT's overall Business Plan seeks to maintain accountability and transparency for processes that may not be standardized across the department.

Stakeholder Expectations

Stakeholder influence can have a very significant impact on target-setting. When external stakeholders become engaged in the process, they can influence which measures are focused upon. These stakeholders range from the public and elected officials to contractors, the construction industry, state and Federal resource agencies, and public safety agencies, among others.

The majority of agencies reviewed with established targets developed them through a committee process that provided for stakeholder input. As such, it provided an opportunity for dialogue about the transportation issues, constraints in funding, and other topics, and as such led to the development of realistic, meaningful targets. This is absolutely critical for state DOTs and MPOs who make decisions in a very litigious environment. It is critical to communicate, not only the lofty, long-term goals for transportation systems, but the reality of fiscal and political and regulatory constraints so that stakeholder expectations can be managed from the beginning. Without this, public transportation agencies would be wary of setting their agencies up for disaster and perhaps even encountering legal trouble. Transportation is a long-term business, with performance typically improved over the long term, but agencies operate in the context of short-term politics, which has a very strong impact on performance-based management. It is often challenging to develop and sustain consistent measurement practices and target-setting to enable meaningful tracking of performance over time.

For example, for the MTC, several different levels of stakeholder participation constitute the long-range planning process. Overarching goals and strategies were set at the executive level. A subcommittee of the MTC Planning Committee, an ad-hoc committee consisting of the nine counties and 26 agencies in the region, derived the measures and targets.

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The MTC Planning Committee voted on and approved measures and targets. The Commission had the final word in approving the targets. Keeping flexibility in the target-setting process, and using language such as "voluntary" and "interim," was critical in getting the Commission to approve targets and properly set stakeholder expectations. This approach also was considered prudent from a legal perspective.

Internal Support

A common theme among many agencies with more developed PBRA processes is internal support and an inside "champion" at a high level. While the MTC's PBRA process in regards to long-range planning has evolved over the development of the last three plans, the Executive Director championed PBRA with staff and elected officials for the development of the MTC's most recent plan. The development of the plan started with the development of performance objectives and the setting of very aggressive performance targets.

The performance-based system in Hennepin County is championed by the County Administrator as well as the Public Works Director. The setting of performance targets at Hennepin County is driven by the top-level managers; as a result, these managers understand the importance of acquiring relevant data.

While these initiatives often begin with strong internal support and an inside "champion," ultimately processes or procedures must be put in place that can transcend administrations or individual staff.

Private Sector Experience

The different mission and vision that private sector companies have from their public sector counterparts results in different priorities and targets. As private companies exist to satisfy their shareholders, the primary driver of shareholder satisfaction is typically corporate profits. Therefore, they typically place little emphasis on public outreach, and they try to avoid or minimize the effect of regulatory burden (versus adhering to and even enforcing regulations, which a DOT must do) in order to streamline operations and minimize cost.

In contrast, transportation agencies heavily weight public policy issues such as social equity, access to urban areas, and urban planning when formulating their policies, whereas few private sector companies take into account public policy considerations when deciding how to allocate their resources or measure their performance. Those companies that factor in public policy to their resource allocation process tend to be in highly regulated and/or capital-intensive industries where public affairs is important to the success of the business, such as rail transportation.

Five environmental variables shape the performance management and resource allocation process and consequently the target-setting process in private sector companies' transportation organizations. Organizational structure, ownership, history, culture, and planning capabilities can combine to form different approaches to performance measurement and management, as described in the following paragraphs:

- **Organizational Structure.** Companies with multiple business units often hold up the highest-performing business unit as the benchmark that the others should strive to beat. Companies that are capital-intensive tend to have more sophisticated capital expense authorization processes. The element of competition is often more important than the specific targets, so some companies let their divisions have a broad role in determining which metrics to use.
- **Form of Ownership (Private Versus Publicly Traded).** Privately held companies are willing to say which metrics they track, but are reluctant to divulge their targets since that might give away competitively valuable information. In publicly held companies (traded on stock exchanges), financial goals inevitably drive the operational goals. In contrast, privately held companies often emphasize operational excellence before financial success in the belief that the former will lead to the latter.
- **History.** Companies that have a long history with a specific performance metric work comfortably with targets based on that metric since the organization understands the past, present, and future using that metric as a reference point.
- **Culture.** In companies with a competitive spirit, the attitude about the numbers is more important than the numbers themselves. In companies with an analytical culture, data collection and analysis is revered and viewed as synergistic with continuous improvement.
- **Planning and Forecasting Capability.** Companies with strong forecasting capabilities are more apt to have long-term goals and targets, whereas companies with weaker forecasting capabilities are more inclined to set annual targets only.

Private sector companies take a different approach to PBRA based on the different nature of the resources that they manage. Staff, capital assets, and budgets may have different targets as well as different target-setting approaches due to their different composition compared to their public sector counterparts, as described in the following paragraphs:

- **Staff.** Most private sector companies employ a mix of full-time, part-time, and temporary employees, so attrition and turnover rates are higher, which makes it easier to implement the Darwinian principle of "survival of the fittest" to allocate staff resources. A bell curve is often used for grading performance, and as individuals outperform their

peers, they get rewarded for their results. In the aggregate, high-performing teams get rewarded, teams on high-performing projects get rewarded, and even high-performing business units also get rewarded as the sum of the individual rewards adds up. A culture of turnover is more permissive of outgoers.

- **Capital Investments.** Compared to fleets that are used in the private sector (often standard trucks, tractors, and trailers), public DOTs sometimes have more specialized fleets that involve a different resource allocation approach. This includes customized and expensive vehicles (such as school buses) as well as emergency vehicles (such as snowplows, police cars, and ambulances) that have inherently lower utilization rates. While both the private sector and public sector DOTs use infrastructure such as terminals, maintenance depots, IT systems, warehouses, and commercial/industrial real estate and buildings, DOTs also might manage some unique buildings and facilities; for example, they may manage toll booths, depots, ports (airports, seaports), and highways that are more local and involve specialized maintenance and repair. So while private sector capital investments are often allocated on the basis of their utilization and payback, public sector fleets are often purchased to meet the peak demand.

- **Operating Expenses.** While private sector companies frequently outsource many aspects of their operations, including IT system development and maintenance, freight auditing, brokerage, and freight carriage, the public sector may use less outsourced services, which makes the public sector's labor cost more solidly fixed cost rather than a resource that can be flexed up and down as needed. The flexibility that comes with outsourcing gives private sector companies more flexibility to base resource allocation on customer contracts.

Furthermore, public sector DOTs may be more representative of large companies, which are characterized by more formal and documented strategies, more timely and predictable planning cycles, more management controls, and longer response times between data gathering and resource decision-making. They have more formal and documented strategies than smaller companies, in part because they work on a longer time horizon (5 years is the norm for large companies). They also have a more defined competitive positioning than smaller companies, which often compete in fragmented, more competitive environments in which competitive analysis is less actionable. Finally, they document their business strategy more formally, in part because large companies frequently have an obligation to shareholders and in part because legislation like Sarbanes-Oxley requires disclosure.

Larger firms have more timely and predictable planning cycles than smaller companies. Capital budgeting is usually done at the end of the fiscal year so as to have a proper budget for the upcoming fiscal year before it starts, and operating budget variances are tracked monthly. They also have more controls than smaller companies. Larger companies have more metrics and more sophisticated measurements (end-to-end, with clearer definitions, etc.) because there are more people to inform. Finally, large companies have longer reaction time than smaller companies because they have to collect fragmented information from a wide network of many locations and aggregated and analyzed in order to determine the appropriate corrective action.

3.3 Approaches for Target-Setting

As discussed earlier, one of the three key objectives for NCHRP Project 8-70 is "to provide a comprehensive description of the process and methods by which targets are set for use in performance-based resource allocation." In support of this objective, a number of private sector and public sector case studies were developed to provide an illustration of PBRA practices, with an emphasis on target-setting as an element of the process. Unique to this study is the in-depth review of private sector applications of PBRA and its best-practice examples of target-setting approaches. Some private sector best practices are applicable to the public transportation sector and can be applied within transportation agencies to improve the public sector application of the PBRA process.

A summary of public sector practice, as illustrated by the case studies in Volume III which is being published as *NCHRP Web-Only Document 154,* is provided in the following sections. A summary of the general PBRA process applied within the private sector follows, along with a description of common target-setting approaches. Public and private sector approaches are reviewed in the context of the seven-step target-setting approach documented in *NCHRP Report 551* and a set of potential revisions to the seven-step approach is provided, based on case study review.

Public Sector Approaches to Target-Setting

As demonstrated in the public sector case studies in Volume III, there is a wide range of agency implementation of PBRA processes and an equally as diverse range of implementation approaches for target-setting as an element of PBRA. The target-setting approach is determined largely by the initial impetus for developing a performance-based process for resource allocation, whether externally driven (e.g., through political or legislative intervention) or internally driven (e.g., strategically developed as a proactive response to the transportation planning and funding environment). Approaches that transportation agencies currently are using mirror, in many respects, the approaches identified in the private sector

examples, with variations occurring primarily in the targets, themselves, and the feedback mechanisms that link actual investment performance to changes in resource allocation. Perhaps the most significant distinction between public and private sector approaches is the private sector's greater utilization and application of targets within the PBRA process, compared to the public sector, where the use of targets is not as common.

Approaches that public sector agencies currently use to set targets, either in isolation or in combination with one another, include the following:

- **Policy-driven** targets established by agency executive management or other external political body (i.e., "top-down" approach). This is an approach in which targets are set in a hierarchical fashion by senior agency management or an external political or legislative authority operating outside of the transportation planning arena. Oftentimes this occurs in response to public outcry or growing public discontent over a transportation issue, with direct action from elected officials being called for. Under this approach, agency senior management or a political body defines targets in the context of larger transportation goals or policies; staff is tasked with developing a transportation investment plan to meet the target and conducting modeling and technical analysis needed to demonstrate attainment of the target under a future funding scenario.
- **Modeling** is often used by agencies to evaluate progress towards targets, even when modeling was not used to establish the target itself. Project and policy scenarios can be tested using travel demand models, combined with other postprocessing tools to include metrics such as benefit/cost to evaluate their relative contribution to progress towards targets.
- **Consensus-based** process where targets are established internally through a collaborative planning process and reviewed/approved by outside, typically management/Board-level sources (i.e., "bottom-up" approach). Under this approach, transportation staff develop targets based on comprehensive analysis of planning context and constraints on possible investment performance, with input from a variety of transportation stakeholders that have an opportunity to impact the process; targets are typically approved by senior management.
- Reliance on formal and informal **customer feedback** in which the transportation system user is viewed as a "customer," and the transportation planning and development process is oriented towards customer-service. Under this approach, direct feedback on system performance and objectives for transportation investment are gathered from the transportation system user through a variety of survey and outreach methods. This feedback is then used by transportation agency staff to develop specific measures and tar-

gets that are closely aligned with the needs of the traveling public (the "customer").
- Use of **benchmarks** from peer agencies, with targets established based on review of similar investment approaches and results experienced by other transportation agencies. Under this approach, criteria should be set for peer group selection and analysis. Once the peer group is set, the analysis will provide a relative status of each state's performance measures and targets. The comparison among states will help guide the final determination of targets within selected performance measure categories.

Policy-Driven

As noted in Section 3.2, one of the most critical factors in establishing targets can be political or legislative intervention in the transportation planning process. In some examples, a political body, senior transportation agency management (sometimes guided by a technical advisory committee), or higher level agencies (e.g., U.S. DOT) will establish a target as an element of the transportation plan and development process. This is a very direct approach and can be a very positive impetus for performance-based planning. It also can create a difficult situation for transportation agencies to navigate if practitioners were not involved in the target-setting process and/or if the process was not informed by real-world planning, funding, and technical constraints that may impact attainment of the target.

Targets set under this approach may often be developed in a more qualitative manner, with less rigorous up-front analysis supporting the target-setting process or, more specifically, with less attention paid to how a target may actually be tracked by transportation authorities given certain technical and resource constraints. Once developed, the targets tend to be well-communicated and well understood (well publicized) and convey a strong message, but success in meeting the target can be very difficult if the agencies and transportation staff responsible for meeting a target are not involved in helping to develop it.

FDOT provides a strong example of a policy-driven target-setting process, with targets that were established by the State legislature. In FDOT, resource allocation decisions are driven by a number of output- and outcome-oriented performance targets in the areas of highway maintenance, Strategic Intermodal System (SIS) funding, and transit funding, as required by Florida statute. These include the following:

- Eighty percent of pavement on the State Highway System meets department standards;
- Ninety percent of FDOT-maintained bridges meet department standards;
- One hundred percent of the State Highway System meets acceptable maintenance standards;

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- Fifteen percent of discretionary capacity funding must be used for transit projects; and
- Fifty percent of discretionary capacity funding must be applied to the SIS (the department's own performance target for this is 75 percent).

The remaining primary targets are set by the Executive Board, and secondary measure targets are set by the program offices and the districts (i.e., the "measure owners"). As these targets are mandated by state law, meeting them is the department's first priority. Determining the standards against which these measures are applied is the Executive Board's responsibility, and so the standards are reviewed as one of the first steps in the Program and Resource Plan and Work Plan update process.

Figure 3.4 illustrates the relationship between goal and target-setting and performance measures in FDOT's bridge program.

There are additional secondary targets for Preliminary Engineering Consultant levels. When FDOT is building their new Work Program, there is an opportunity to bring forward new specialty projects. However, there is political pressure to add highway capacity expansion projects with any available resources left over. Consultant targets are set so that the level of engineering activity is maintained and the production pipeline keeps going.

FDOT currently is postponing, reducing the size/cost, or removing projects due to revenue reductions. The first area likely to be cut is capacity expansion projects because maintenance targets are "sacred." One would logically expect that consultant levels also would go down, but FDOT is struggling with how to set the target to determine the appropriate level of reduction. FDOT previously used right-of-way (ROW) acquisition targets as a measure to keep production going, but the Executive Board chose to do away with them because ROW

land resources are decreasing. Historically, FDOT reset engineering consultant targets to whatever level is projected in the Work Program for four common years. They perform a trend comparison to construction levels and project what levels of preliminary engineering are needed. The Department is considering alternative methods for setting targets.

Modeling

Modeling is often used by agencies to evaluate progress towards targets, even when modeling was not used to establish the target itself. Project and policy scenarios can be tested using travel demand models, combined with other post-processing tools to include metrics such as benefit/cost to evaluate their relative contribution to progress towards targets.

Both top-down and bottom-up modeling are used to set targets in many companies. Top-down modeling most commonly drives the target by high-level requirements. Top-down modeling determines the strategies or funding needed to achieve the target; bottom-up modeling determines what level of performance is possible, and then uses that to calculate the expected target, as Japan's MLIT does annually.

The exact use of modeling depends to some extent on the way in which an agency is utilizing PBRA. For what part of the investment process is the agency setting targets? For example, are the annual financial targets, long-term targets for a long-range transportation plan, or mid-term targets for a package of projects and programs to be included in a TIP?

Many agencies have found innovative ways to incorporate performance-based processes and targets into their planning processes and duties, supported by modeling. The MTC uses its own StreetSaver® PMS to calculate preventative maintenance funding targets for its local jurisdictions; the ratio of "actual versus targeted" determines the jurisdiction's performance score
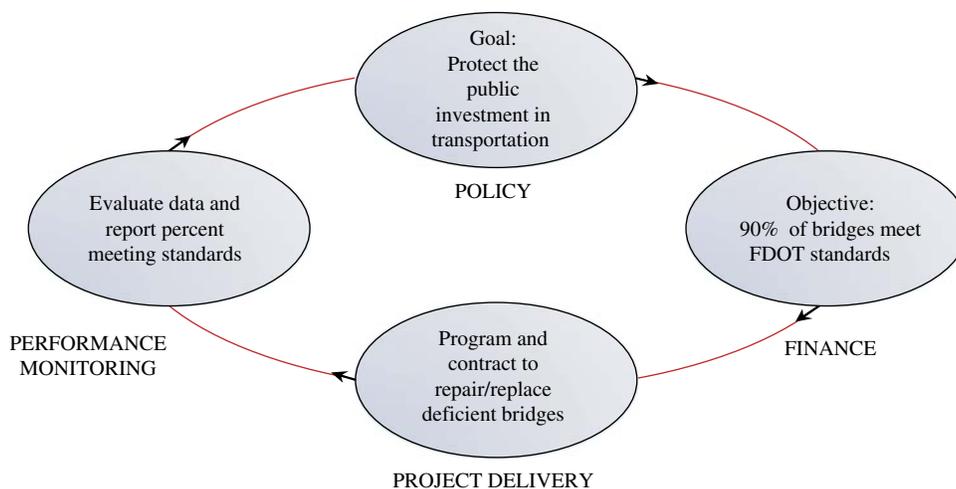

Figure 3.4. PBRA for FDOT bridge program.

and is a factor in calculating the amount of funding that will be allocated to that jurisdiction.

Consensus-Based

In many cases, transportation agencies develop targets through an internal, consensus-based planning process as part of a more comprehensive PBRA exercise. Typically, the use of specific targets derived from an internal process is seen in agencies with a more sophisticated and well-developed PBRA system that has developed over several iterations. Staff resources and time permitting, an internally developed process can lead to very meaningful and effective targets within an agency's PBRA process.

The MTC provides an excellent example of an externally mandated (policy-driven) intervention that supported, rather than dictated, an internally managed, consensus-based, target-setting approach. In this case, the California state legislature had required PBRA to be a part of transportation plan development, and for some critical areas, established targets itself (e.g., CO_2 reduction). This political intervention served to strengthen the role performance assessment played in the planning process and allowed real leadership to emerge in this area, in MTC's case, at the Executive Director level where the opportunity was provided for PBRA to be championed with staff and elected officials. As part of the ongoing 2035 RTP, targets have been established for three principal focus areas: Economy, Environment, and Equity. Environmental targets, for example, include a 40 percent reduction in CO_2 below 1990 levels, 10 percent reduction in $PM_{2.5}$ below 2006 levels, 45 percent reduction in PM_{10} below 2006 levels, and 10 percent reduction in VMT per capita below 2006 levels. MTC staff have recently completed an exercise to test how different system expansion strategies contribute to achieving these predefined performance targets. Because the MTC is in the early stages of conducting plan analysis against performance targets, there is no direct impact on resource allocation that can be determined or is documented yet.

For those targets that the MTC developed, an internal planning team (bottom-up) approach was used. This type of approach is common for transportation agencies using PBRA. Goals and objectives were established at an executive level, and a subcommittee of the MTC representing the various jurisdictions in the region derived the measures and associated targets through a more technically informed process. The MTC Board formally adopted the targets as part of the larger PBRA system. Note that the MTC emphasized that keeping flexibility in the target-setting process, by using language such as "voluntary" and "interim" in regards to Board adopted policy, was critical in getting targets approved. As noted in Section 3.1, it is important for transportation agencies to keep in mind the litigious environment in which they work and not set themselves up for failure in regards to not meeting targets, in light of so many success factors being outside of their control.

Customer Feedback

As stated in Section 3.2, those agencies that have taken a clear customer-service approach within the resource allocation decision-making process understand the need to use targets that communicate to the system user, the "customer," the return on their investment. Customer satisfaction is a fundamental aspect of performance for these organizations and permeates the process for how potential investments are evaluated and selected to receive funding.

Coral Springs, Florida, provides a very strong example of a municipality that has taken a very direct customer-service approach towards its resource investment process, in which customer input drives the decision-making process for a wide range of services, to include transportation. Target-setting is a key component of the Coral Springs process as it provides a direct translation of progress as feedback for a community that has been actively engaged and empowered as part of the planning process. Community feedback is gathered through a variety of methods to include, but not limited to, an Annual Citizen Survey, public hearings, a city blog, regular visioning exercises and focus group discussions, a complaint tracking system, and employee surveys. The Coral Springs customer input process is extensive, formal, iterative, and continuous and impacts, to a significant degree, the target-setting approach. With regard to transportation, three targets have been established directly from customer feedback which indicated growing concern over traffic mobility and safety issues. These include a 10 percent speed reduction on traffic-calmed street, reducing intersection crashes to no more than 165, and increasing city transit ridership to 125,000 annual trips.

Hennepin County, Minnesota, also provides an example of a customer-oriented approach to target-setting. Hennepin County is the largest local government in Minnesota, located within the Twin Cities Metropolitan Area, and has been rated among the best managed large counties in the country. Beginning in 2002, Hennepin County introduced a strategic management framework that focused on results and customers. Hennepin County uses the Balanced Scorecard (BSC) approach as a management tool, which helps to align county daily work with the county vision and goals in the context of community needs. The "customer" is one of the four perspectives that the BSC approach is viewed from as part of the PBRA process (the other three being: Finance, Internal Process, and Leaning and Growth). The Hennepin County Public Works Line of Business has six functional areas, including (1) emergency services, (2) environmental, (3) energy, (4) housing and public works, (5) transportation, and (6) administrative services. These functions are at varying stages in setting perfor-

mance measure targets. For some measures targets have not yet been set. However, the Business Line is on track to develop a complete menu of measures and targets for all functions in the near future. In the transportation service area, a number of specific targets already exist and include targets related to bridge and pavement sufficiency ratings, reducing crash rates, completion of the Bicycle System Plan, and project delivery standards.

Benchmarking

Benchmarking as a target-setting approach provides a transportation agency with the means to establish targets in a relatively quick and efficient manner that can be realistically achieved. Benchmarking is often handled by a scan of peer agencies that have attempted to reach similar goals through similar types of investment packages. It allows peer agencies to observe realistic performance outcomes for various types of transportation improvements and investment levels, and therefore supports a realistic target-setting approach.

In the case of the Maryland State Highway Administration (SHA), for example, targets are developed with input from appropriate managers and data owners, using outside data, trends, and best practices to assist when possible (e.g., benchmarked against peer states). Performance measurement has been integrated into daily agency operations and elevated as a planning and technical necessity. Targets are established by the agency performance measure "lead" who is responsible for maintaining and reporting data for a particular measure and ensuring data accuracy. Note that by identifying a measure "lead," the SHA also is facilitating a sense of ownership and responsibility for performance measurement and integrating the practice into an overall agency culture of performance.

While most public sector agencies do not formally use benchmarking to set performance targets, there is nonetheless an emerging interest in comparing the use of measures and targets across jurisdictions. The AASHTO Standing Committee on Quality, recently renamed the Standing Committee on Performance Management, conducted a study in 2007 which identified best practices for highway project delivery times and cost. The committee also has identified best practices for smooth pavements.

The current movement to establish a more performance-based Federal-aid highway program also underscores the importance of establishing measures and targets that can be uniformly applied across states and MPOs. This interest is consistent with trends in New Zealand and Australia. The Austroads National Performance Indicators (NPI) system includes dozens of indicators in 11 broad groupings, covering safety, asset management, environmental impacts, system capacity, user satisfaction, and project management, among other things. The NPI data are noteworthy not only for the breadth and sophistication of the indicators used but also because they present consistent and comparable data across a transportation system managed by nine separate agencies in two countries, allowing unprecedented benchmarking possibilities. Specifically, benchmarks against other jurisdictions also are being introduced into VicRoads' process.

MTC developed a pavement management system called StreetSaver® that is used by nearly all local jurisdictions in the Bay Area. Local pavement condition data is used by MTC at the regional level to generate a regional pavement condition summary and PCI index, which they then use to predict regional needs for pavement maintenance as part of their regional transportation planning process and which can be used as a benchmark among local governments.

While there are five basic approaches to setting targets, the policy-driven approach tends to dominate the target-setting methods used by the agencies reviewed, followed by consensus-based approaches. This makes sense in light of the significant transportation funding issues that have impacted all transportation agencies at the state, regional, and local level throughout the country over the last few years. These funding issues have created a situation in which competition is increasing for ever-decreasing transportation dollars and in which more accountability is being demanded of elected officials and transportation authorities in how limited dollars are spent. This creates a situation in which performance-based processes flourish and one in which decision-makers may establish investment mandates or requirements quickly to show action being taken.

While the policy-driven approach to target-setting is the most frequently used today, the advantages and disadvantages of all four approaches need to be considered as practice matures. These advantages and disadvantages are summarized in Table 3.1.

Private Sector Target-Setting Approaches

Organization accountability in the private sector is strong and direct. Organizational hierarchies are critical in determining reward and penalties for performance versus target. The classic pyramidal hierarchy still often drives behavior, despite the existence of numerous more modern organizational structures that divide businesses by strategic business unit (SBU) or product line. Matrix structures also have become popular, but practically speaking, reporting relationships are typically characterized by one dominant boss. The implication for transportation management is that accountability to that one boss is critical, and performance is usually judged by one person with abundant data. This may contrast with organization accountability in the public sector.

Table 3.1. Managing risk of public sector target-setting approaches.

Target-Setting Approach	Advantage	Disadvantage	Approach to Balancing Advantages with Disadvantages
Policy-Driven	• Linked to PBRA elements	• Political process may ignore PBRA	• Establish PBRA with legislative participation to ensure support and understanding
Modeling	• Defensibility. • Better understanding of future performance.	• More time and money intensive. • Models change over time.	• Continue to refine modeling techniques. • Use hybrid approach.
Consensus-Based	• Insures broad understanding and acceptance within agency	• May flounder in effort to be inclusive	• Appoint internal champion to lead effort to identify the "critical few" measures and targets
Customer Feedback	• Insures more transparent process	• May be confusing to discuss technical measures with public	• Describe measures and targets in the simplest terms possible
Benchmarking	• Provides a peer group comparison	• Can be misused for comparative rankings	• Continue to refine comparative analysis techniques

The Budget-Setting Process

Budgets play a critical role in decision-making. Whereas in the public sector a balanced budget may be an option, in the private sector it is the only way businesses work. The fiscal year's budget must balance. In addition, budget variances are tracked, and monthly variances are addressed promptly. Large variances usually result in some sort of realignment of resources—especially headcount, job responsibilities, or equipment allocation. In addition, IT systems and processes are often re-engineered to achieve the budget figures.

Key Performance Indicators (KPI) are prevalent and are usually prominently posted in managers' offices. These reflect the measures for which individuals are responsible and often to which compensation is tied.

The budgeting process begins with functional and business unit heads agreeing on key performance indicators that accurately reflect their unit's success. The metrics typically fall into five categories: cost, quality, service, speed, and delivery.

The determination of metrics that are important to the organization as a whole includes identifying the hierarchy of metrics, including especially which ones are important enough to be on the executive dashboard. Usually, this consists of a set of metrics that are common to all subsegments of the business. It should also include a determination of which metrics should be visible at different levels of the organization. Usually, these consist of the metrics that are important to specific subdivisions with common geographic areas, types of infrastructure, or financial structures.

The selection of metrics should reinforce the objectives of the company, which usually include at a minimum: (1) Fixed asset minimization, both in terms of the number of units, as well as the value per unit; (2) Operating cost minimization; and (3) Service level maximization, including flexibility (the ability to respond quickly to temporary changes in circumstances) and agility (the ability to adapt to structurally changed circumstances).

Transportation cost, in its various permutations such as cost per shipment, cost per mile, cost per order, cost by traffic lane, and others, is often separated into several different categories:

- **Total unit cost**—the cost per unit with the numerator being cost and the denominator being a volume metric such as miles, stops, or orders or a resource metric such as the number of vehicles or drivers
- **Transportation cost separated from product costs**—transportation budget or actual total transportation cost, tracked rather than imputed as an "adder" as a percent of revenue, which is a common practice among many companies
- **Landed cost**—transportation plus other costs incurred in moving product through a supply chain such as customs, insurance, interest, and storage costs. Landed cost is most often used in importation since duties and inventory carrying can represent substantial costs compared to transportation.
- **Cost avoided**—money that would have been spent but does not have to be due to a change, for example, in processes.
- **Quality-adjusted cost**

Profitability also is reported in several different ways:

- **Revenue**—If transportation is a profit center for the company.
- **Operating ratio**—operating cost divided by operating revenue.

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- **Customer profitability**—profit measured in various ways, such as revenues minus expenses or percent profit margin at the customer level. This metric is used by companies that have sophisticated enough information systems to track and attribute transportation cost to specific deliveries and customers.

Return on investment is measured by relatively few companies (as it applies to transportation operations). It is mostly applied on a case-by-case basis to specific investments in equipment or warehousing. However, the following three new trends are making return on investment a more popular performance measure:

- The drive to remove assets from the balance sheet through off-shoring and outsourcing;
- The evaluation of investments in off-shoring have gained popularity recently, especially as much sourcing shifted overseas to China, and the value of the U.S. dollar has fallen so sharply as to cause many of those same companies to evaluate moving the production back onshore; and
- Intense interest in public-private partnerships (PPP). In such models, each party lobbies for their share of public money while trying to give up as little of their own private capital as possible.

Beyond profitability and return on investment, shippers and carriers use a wide variety of important performance metrics that often measure their ability to fulfill customer orders reliably and quickly. These include metrics related to volume, velocity, total supply chain costs, quality of customer interface, volatility, and security.

Then, through a process that may be automated to varying degrees, Production, Procurement, Operations, and Logistics all share important information that is used to facilitate the control and feedback loop. The actual metrics depend greatly on the company itself and on the mission, vision, objectives, and targets set in the Planning process. To use cost as an example, the following departments provide cost feedback:

- Production (if a manufacturing company) shares its direct costs and its indirect costs:
  – Direct costs are based on labor consumed, material consumed, and net of any byproducts created that have market value.
  – Indirect costs, often called Manufacturing Overhead, are allocations of fixed costs such as plant and equipment that is used to produce multiple product types or serve multiple channels, and labor that is dedicated to planning and control.
- Procurement shares its acquisition costs. Acquisition costs include the cost of purchasing an item or service, plus the

cost of transportation, duties and taxes, shipping, handling, and insurance.
- Operations shares its direct operating and maintenance costs for the equipment that Procurement buys.
- Logistics shares its transportation, warehousing, and packaging costs. In addition, Logistics may track inbound freight costs for the material it acquires from external suppliers, since it is part of the overall supply chain.

Accounting, usually a part of the Finance department, often compiles the budget and the actual cost data, and produces variance reports that are shared among line managers who have profit and loss (P&L) responsibilities, as well as executive managers to whom those P&L heads report. Where there is an ERP system or other executive dashboard, these metrics may auto-populate and be accessible to authorized managers via a corporate intranet.

Executive management interprets the variance reports in light of a wide array of factors, including the following:

- External market conditions influencing demand for the company's products and/or services;
- Competitive conditions, including price and non-price competition; and
- The pace of internal ongoing research and development (R&D) programs, cost management initiatives, and other corporate programs that could affect the managers' ability to meet their budget targets.

Based on the review and assessment, executive management may exercise considerable discretion in reacting to updates. Good variances may elicit no response, a pat on the back, a resetting of the budget targets, a promotion, or a raise. Depending on the seriousness, bad variances could elicit no response, a root-cause analysis, a review, or resetting of the individuals' targets or budget allocation, a demotion, or even termination.

Organizational and Motivational Approaches to Target-Setting

Private sector companies take a variety of different approaches to governing the target-setting process. The following four different approaches can be seen in companies, including a hybrid approach:

- **Edict.** Don't over analyze. Just state the goal and have everybody try to hit it. The underlying principle of this approach is that success in hitting the target is entirely a function of motivation and execution and that planning is a relatively minor part of reaching the target. This approach also is called "Ready-Fire-Aim." The advantage of the

Edict approach is that the target is unequivocal and well-understood throughout the organization. The challenge is that the approach is not inclusive or consultative; it is more characteristic of old-fashioned hierarchical leadership. For example, the choice of metrics and targets is made by senior management and is not subject to discussion.

- **Benchmarking.** There are three basic varieties of benchmarking: Best-in-Company, Best-in-Industry, and Best-in-Class. In all the cases, benchmarking means identifying a reference point or points and using them as the basis for one's own target. The internal target can be higher or lower than the benchmark, but in either case the reference point is used to determine the target. Benchmarking also can be qualitative. For example, strategic benchmarking can identify similar companies' strategies as a basis for setting one's own strategy. Organizational benchmarking can be either qualitative or quantitative. One common form or organizational benchmarking is measuring staff levels used to service a given level of activity.
  - Best-in-Company benchmarking fosters competition between operating units on the basis of the key metric(s).
  - Best-in-Industry benchmarking analyzes the performance of companies in the same industry or segment and highlights the best in the group as the benchmark, even if its activities are not directly comparable to the subject company.
  - Best-in-Class benchmarking analyzes the performance of a broad range of entities, including some with unrelated activities, and highlight the best in the group as the benchmark, even if it is in a different industry than the subject company.
- **Modeling.** Both top-down and bottom-up modeling are used to set targets in many companies. Top-down modeling most commonly drives the target by high-level financial requirements. Top-down modeling determines the operational effectiveness needed to achieve the financial target and sets the operational target around that. Bottom-Up Modeling determines what level of operational performance is possible and then uses that to calculate the expected financial result.
- **Hybrid.** Hybrid approaches use some combination of the other approaches. Different approaches may be more or less effective in different departments or business units with different management styles as well as over time as the needs of an organization change. Hybrid approaches can be extremely effective because of their versatility and durability. Their drawback is that they can dilute the strong message that might come from the other approaches, especially the edict approach.

Positive execution versus targets can result in increased allocation of resources for upstream infrastructure such as terminals and warehouses but usually after a lag. Moreover, the prime driver of such an increase in resources is a pass-through of savings to the customer, who then decides to increase volume through the system due to that company's (or individual's) cost savings.

Therefore, the initial response to cost savings is often a downsizing—reduction of warehouses, reduction of inventory, reduction of vehicles in the fleet, and reduction of suppliers. The second-order effect of such reductions is to decrease the cost of distribution; this savings is passed on to customers in the form of lower prices, which can subsequently generate increased sales. These increased sales then require more infrastructure to handle a higher volume of goods moving through the distribution network.

Aside from the budgeting process, private sector companies' approach to resource allocation also includes the use of variable compensation, team competition, wide access to performance data, and simple and stable performance metrics. Most companies use compensation. However, they use each lever to varying degrees. The following paragraphs describe these methods in further detail:

- Salary and incentive bonuses are powerful motivators and result in targets that are driven by what people can achieve rather than calculated guesses. Also, compensation that varies depending on performance versus the target is widely viewed as an effective way of motivating performance.
- Intracompany team competition also is an effective way to motivate performance and establish the right targets based on what can be achieved through competition rather than on a calculated target. Seeing a business unit succeed can stimulate an aggressive response from a competitive peer. The Baldrige winners use internal competition extensively to instill creativity and better results.
- Wide and easy access to targets and performance data helps stimulate better knowledge of current performance and performance gaps, hence the ability to improve performance and to do it more rapidly. In contrast, complexity and waffling will dampen attempts to improve performance, according to most interviewees. Three Baldrige winners—FedEx, Cargill, and Ritz Carlton—plus several Balanced Scorecard users such as CSX, Caterpillar, and BASF, rely heavily on the wide dissemination of performance data inside their companies.
- Simple measurements. Complex measurements and multi-faceted metrics dashboards, while intellectually appealing, are counter to common wisdom in the private sector, where one simple and clear target for transportation and logistics per year can achieve significant improvement through alignment of goals. Companies that use Total Quality Management (TQM) rely heavily on simple metrics because changes are implemented at the shop floor level where data must be

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readily obtained and recorded in order to be credible and immediately actionable.

- Stable measurements. Changes in the definition of metrics over time can stifle motivation to achieve the target, as well as raise non-value-added confusion and ambiguity about how to interpret the target or how to interpret performance compared to what it was when historically different metrics were used. Companies that use balanced scorecards need stability of metrics more than most because unstable metrics make the scorecard appear unbalanced.

Using each approach to measuring comes with some risks. Table 3.2 outlines the advantages and disadvantages of each approach as well as approaches to mitigating those disadvantages. To develop the best approach for target-setting in a given environment, the advantages and disadvantages could be quantified on a scale with the disadvantages netted

from the advantages and then the highest-scoring result would be the best approach.

Application of the Seven-Step Target-Setting Approach Within the Public Sector

The seven-step process for setting targets found in *NCHRP Report 551* is exemplified in varying degrees for each approach. The following are the seven steps:

1. Define the context for target-setting and establish time horizon(s);
2. Determine which measures should have targets;
3. Develop long-term goals based on consideration of technical and economic factors;
4. Consider current and future funding availability;

Table 3.2. Managing disadvantages of private sector target-setting approaches.

Target-Setting Approach	Advantage	Disadvantages	Approach to Balancing Advantages with Disadvantages
Incentive Bonuses	Strong motivator	Inequalities	Team or group bonuses
	Results in a "natural" target	Could sacrifice performance on one parameter in trying to maximize another	Nonmonetary rewards
Intra-Organizational Competition	Results in a "natural" target Stimulates sharing of best practices	Could sacrifice performance on one parameter in trying to maximize another	Stimulate internal competition based on a balanced scorecard of metrics
Wide Access to Targets and Data	Facilitates more improvement ideas	Education and interaction with peripheral users of the data could derail progress	Apply varying levels of access permissions
		Technology to disseminate the information could be costly	Use web-based gathering and filtering of input
Simple Metrics	Focuses effort, resulting in quicker target attainment	Could encourage gaming, whereby people sacrifice performance in some areas in order to hit a simplistically defined target	Use a set of simple metrics that prevent gaming by imposing tradeoffs
Stable Metrics	Deeper penetration of targets into processes	Slow to adapt to changing external environments	Periodic review cycle to ensure metrics are optimal
Baldrige Awards	Process focus allows for evolution of targets	Targets may not be simple or easy to remember	Hybrid approach
Balanced Scorecard	Prevents gaming and suboptimization	Complex; diversity of metrics inhibits the progress that often results from focusing on one simple target	Hierarchy of metrics
Total Quality Management	Deep penetration into culture when fully implemented	Requires a long-term commitment	Hybrid approach

Source: Boston Strategies International, Inc.

5. Analyze resource allocation scenarios and tradeoffs;
6. Consider policy and public input implications for target-setting; and
7. Establish targets and track progress.

In general, the seven-step process is not used in a formal fashion for a policy-driven process. For internally developed processes, there tends to be more leeway and opportunity to allow the full seven-step process to take place, although in most cases only some of the seven steps are actually implemented. For approaches relying on customer feedback, the process is driven more by customer demand as opposed to a comprehensive analysis supported by the seven-step approach, and, similarly, with a benchmarking approach, the seven-step process is not as critical because targets are set based on other agency practices. The application of the seven-step process in the public sector is described in more detail in the following paragraphs.

In a policy-driven approach, the motivation for the performance-based process and target-setting may be politically driven. Unless guided by a technical advisory committee or a technical stakeholder group, this process is not likely to take into account in real detail the very critical aspect of data and tools needed to develop meaningful targets and to track performance of potential investment in relation to the targets (e.g., data availability, data history, data forecasting capabilities, performance analysis, etc.). In addition, timeframes to set targets may likely be limited so that policy bodies can show action being taken in an effective manner. With this in mind, Steps 1, 3, 5, and 7 are not often applied as these address the more comprehensive requirements for a complete target-setting approach. However, policy bodies, senior management, and elected officials often times are able to focus on key measures of interest (as they relate to a particular transportation issue) and can determine which of these need targets to demonstrate progress to the public and their constituencies (Steps 2 and 6). For example, traffic congestion and environmental issues such as climate change or air quality that garner significant public interest may help to focus decision-makers on these two steps that address how the performance of transportation investment should be evaluated, and how it should be communicated and reported considering public input.

With consensus-based processes, where targets are established internally through a collaborative approach, there is more time to pursue a comprehensive methodology that is more inclusive of each of the seven steps. By default, a consensus-based approach will require more time and greater level of technical and planning effort because of the variety of stakeholders that will be involved in the process, each providing a unique perspective that will warrant attention. As demonstrated in the public sector case studies in Volume III, no one agency included all seven steps in its consensus-based target-setting approach, nor did any agency cite an approach to target-setting that included so many disaggregate steps. In most cases where target-setting was developed through a consensus-based approach, the agency was working within a framework where long-range goals were defined (Step 3); these provided the foundation for the establishment of objectives and performance measures and targets, as appropriate based on technical resources (Step 2); this process was informed by stakeholder discussion of the larger planning context to ensure the development of reasonable targets that are politically palatable and attainable given real-world planning and funding constraints (Steps 1, 4, and 6), and targets were then established with progress tracked, resources permitting (Step 7). Note that Step 5—"analyze resource allocation scenarios"—was not shown to be a step often taken in the target-setting process, but rather as a part of transportation plan and project development where potential resource allocations were analyzed in terms of how well they helped the agency meet particular targets.

Modeling applies most directly to Step 5, though it is likely done in concert with other processes (such as consensus-based processes) applied to earlier steps. However, when modeling is being used to determine targets, model and data limitations are likely to help determine which measures should have targets (Step 2). Step 4 can directly lead into Step 5 by determining the scenarios to be modeled based on financial constraints; conversely, Step 5 can be used to determine the amount of funding necessary.

For approaches based on Customer Feedback, the seven-step process is not as applicable because the primary driver in the process is developing targets that communicate to the customer the investment performance in terms that the customer cares about, as opposed to communicating performance in terms of transportation planning and development standards. The target-setting process is still informed by and supported by transportation practitioners that provide the appropriate context for establishing targets (e.g., what percentage of crashes might be expected given certain funding levels, or how much speed may decrease as a result of traffic calming measures), but ultimately processes oriented towards the customer are driven by the customer perception of what needs to be improved and by how much. As such, most of the seven steps have not shown to be strictly applied.

Benchmarking approaches tend to be even less supported by the seven-step process. Targets set under this approach are done so based on experience in peer states and/or given similar types of investment packages to support similar transportation goals. Case study review or scans of peer agency transportation investment performance provide an assessment of what can be expected in terms of impact and performance for various types of transportation improvements and investment levels. Targets are then established based on a relative comparison between peer regions.

Application of the Seven-Step Target-Setting Approach Within the Private Sector

A close look at the private sector experience with performance management might suggest some revisions, particularly in the timeframe of targets and in the correspondence of targets to metrics. Three edits would align the 551 process more closely with private sector best practices:

- A rephrasing of Step 1 ("Define the context for target-setting and establish time horizon(s)") might be "Define the context for target-setting and establish annual targets." Private sector experience would suggest that time horizons be kept to a minimum. For example, DIY sets its target annually. Corporation X has short- and long-term targets. None of the companies interviewed had more than two target timeframes. Private sector companies often have a 1-year target and a 3-year target. Also, the actual number of number targets, as they apply to transportation, should be no more than a few in order to achieve organizational alignment around a common goal.
- A rephrasing of Step 2 ("Determine which measures should have targets") might be "Assign a target to each metric or else eliminate the metric." Private sector companies (MNC is an example) are sensitive to "analysis paralysis," and therefore prefer to measure only what actually has a target. Measuring things that do not have targets can cloud performance management with ambiguity. Measures without targets increase the number of numbers people study, decreasing from the emphasis on a single core target. It also implies an incompleteness of the target-setting process, as if the architects of the performance management process did not go all the way in determining how various metrics are inter-related, and which are more important than others.
- Step 5 ("Analyze resource allocation scenarios and tradeoffs") might be better split into two steps: (1) determine the return on capital investment and (2) compute the cost/benefit ratio of operating expenses. This step has two underlying and different decision lattices—the first has to do with capital expenditures, and the second has to do with operating expenditures. Private sector firms (ABC Logistics is an example) generally allocate capital dollars according to their return on investment and operating dollars based on their profitability. Most (with the exception of Corporation X) do not consider scenarios, but they should. Return on investment can and should include the costs and benefits to all stakeholders, public and private. There are guidelines for calculating return on investment in public-sector work and in public-private partnerships. The calculation of profitability depends as much as possible on assigning benefits and costs to specific user groups, as in toll road pricing analyses.

3.4 Role of Economic Models and Management Systems in Target-Setting and Tradeoff Analysis

As previously indicated, modeling provides a quantitative approach to target-setting. This section provides an initial identification and analysis of the potential roles for economic models and management systems in setting performance targets and in supporting tradeoff analysis. The focus is on the role of economic analysis in these functions. However, since many of the useful procedures which perform some aspects of economic analysis are termed management systems, this discussion also includes those management systems which provide economic analysis and which already are used for or are potentially useful for target-setting and tradeoff analysis. The focus of this section is on target-setting and tradeoff analysis at the system or program level, which could apply to the nation, states, metropolitan areas, other regions, or to modal or multimodal agencies. Economic models and management systems also are useful for determining the impacts of projects on performance targets or for doing project level tradeoff analysis. While examples are provided from current practice, and the potential for extensions of current practice are discussed, it is important to keep in mind that economic models and management systems are by no means sufficient in themselves for setting performance targets or assessing tradeoffs.

Usefulness of Current Economic Models and Management Systems in Target-Setting

There are current useful and outstanding examples of the potential for the use of economic models and management systems in setting performance targets. In some cases, those procedures are not being formally used to help to set targets. In other cases, they have been used by agencies to set short- or long-term targets or to illuminate tradeoffs.

The most often cited examples of economic model systems which can be readily adapted to a positive role in target-setting and tradeoff analysis are the FHWA's Highway Economic Requirements System (HERS) and the National Bridge Inventory Analysis System (NBIAS) which are currently used by FHWA in highway and bridge analysis for the periodic reports on "Status of the Nation's Highways, Bridges and Transit: Condition and Performance," commonly referred to as the "C&P" reports. The 2008 C&P report, which was recently released in late January 2010 includes many exhibits which illustrate how HERS and NBIAS can be used to determine the relationship between investment levels in highways and bridges and important performance measures. The transit sections of the report, which are not discussed here, provide similar information relating transit investments to transit performance measures.

Several figures included in this chapter are exhibits taken directly from the 2008 C&P and illustrate a few of the performance measures that HERS and NBIAS can relate to levels of investment in bridges and highways. The 2008 C&P report contains these and other exhibits which illustrate the impacts of different investment levels on performance measures including user costs, user delays, levels of service, pavement condition measures, and the backlog of bridge needs.

The use of the HERS for producing the exhibits shown is not straightforward but requires the very sophisticated knowledge of those at FHWA and Volpe who produce the C&P. Many alternative runs of the HERS are needed to produce the results shown in the exhibits. Since most states are not yet familiar with the use of the state version of HERS (HERS-ST) and since the exhibits which are very useful in

target-setting require repetitive runs and the post-processing assembly of the results, there will be a great deal of education and training needed to transfer the FHWA capability to use HERS for target-setting to the states. It would be highly desirable to foster the dissemination of HERS, HERS-ST, and state economic analysis procedures and capacity building at states and MPOs.

The bridge model, NBIAS, produces the results which are potentially useful for target-setting more directly by relating investment levels to performance measures. However, the states have not utilized NBIAS. Most states do have the PONTIS bridge management system, which they could use to help inform target-setting and tradeoff analysis.

Figure 3.5 taken from the 2008 C&P illustrates the relationship between alternative investment levels and overall con-

Projected Changes in 2026 Congestion Delay and Incident Delay Compared With 2006 Levels for Different Possible Funding Levels and Financing Mechanisms

Annual Percent Change Relative to 2006	Average Annual Capital Investment (Billions of 2006 Dollars) [1]		Percent Change in Delay on Roads Modeled in HERS					
			Congestion Delay per VMT			Incident Delay per VMT		
			Funding Mechanism [2]			Funding Mechanism [2]		
	Total Capital Outlay	Spending Modeled in HERS	Non-User Sources	Fixed Rate User Charges	Variable Rate User Charges	Non-User Sources	Fixed Rate User Charges	Variable Rate User Charges
7.76%	$188.9	$115.7	-1.8%			-29.7%		
7.45%	$182.0	$111.5	**-0.3%**	-4.6%		-28.3%	-33.1%	
6.70%	$166.5	$102.0	**3.0%**	**-0.7%**		-24.9%	-29.2%	
6.41%	$160.9	$98.6	4.3%	0.6%		-23.7%	-27.5%	
5.25%	$140.6	$86.1	8.8%	5.8%		-17.5%	-20.8%	
5.15%	$139.0	$85.1	9.3%	6.5%		-17.0%	-20.0%	
5.03%	$137.1	$84.0	9.8%	6.9%		-16.4%	-19.4%	
4.65%	$131.2	$80.4	11.2%	8.8%		-14.6%	-17.1%	
4.55%	$129.7	$79.5	11.8%	9.4%	-8.3%	-14.1%	-16.7%	-36.6%
4.17%	$124.2	$76.1	13.3%	11.1%	-7.3%	-12.7%	-14.9%	-35.4%
3.30%	$112.6	$69.0	17.1%	15.5%	-5.4%	-8.2%	-9.4%	-32.7%
3.21%	$111.5	$68.3	17.5%	15.9%	-5.2%	-8.0%	-9.1%	-32.5%
3.07%	$109.7	$67.2	18.1%	16.7%	-4.8%	-7.4%	-8.6%	-32.2%
2.96%	$108.4	$66.4	18.4%	17.0%	-4.6%	-6.9%	-8.1%	-31.9%
2.93%	$108.0	$66.2	18.5%	17.1%	-4.5%	-6.8%	-8.0%	-31.8%
1.67%	$94.0	$57.6	22.8%	22.1%	-1.6%	**-2.3%**	**-2.9%**	-27.8%
0.83%	$85.9	$52.6	25.6%	25.4%	**0.0%**	**1.1%**	**1.0%**	-25.4%
0.34%	$81.5	$50.0	27.2%	27.3%	1.1%	2.8%	2.8%	-23.8%
0.00%	$78.7	$48.2	28.4%	28.6%	1.8%	4.0%	4.2%	-22.6%
-0.78%	$72.5	$44.4	31.7%	32.2%	3.0%	8.2%	8.7%	-20.5%
-0.86%	$71.9	$44.1	32.0%	32.5%	3.2%	8.6%	9.1%	-20.3%
-1.37%	$68.3	$41.8	33.9%	34.6%	4.0%	10.6%	11.4%	-19.0%
-4.95%	$48.2	$29.5	44.1%	45.9%	8.9%	23.3%	24.9%	-10.7%
-7.64%	$37.9	$23.2	50.4%	53.0%	10.7%	32.0%	34.1%	-7.7%

[1] The amounts shown represent the average annual investment over 20 years that would occur if annual investment grows by the percentage shown in each row in constant dollar terms. The performance impacts identified in this table are driven by spending modeled in HERS; the figures for Total Capital O utlay" are included to reflect other spending not modeled in HERS.

[2] The funding mechanism used to cover the gap between a particular funding level and current spending will have different impacts on future travel behavior, which will impact the level of performance that would be achieved.
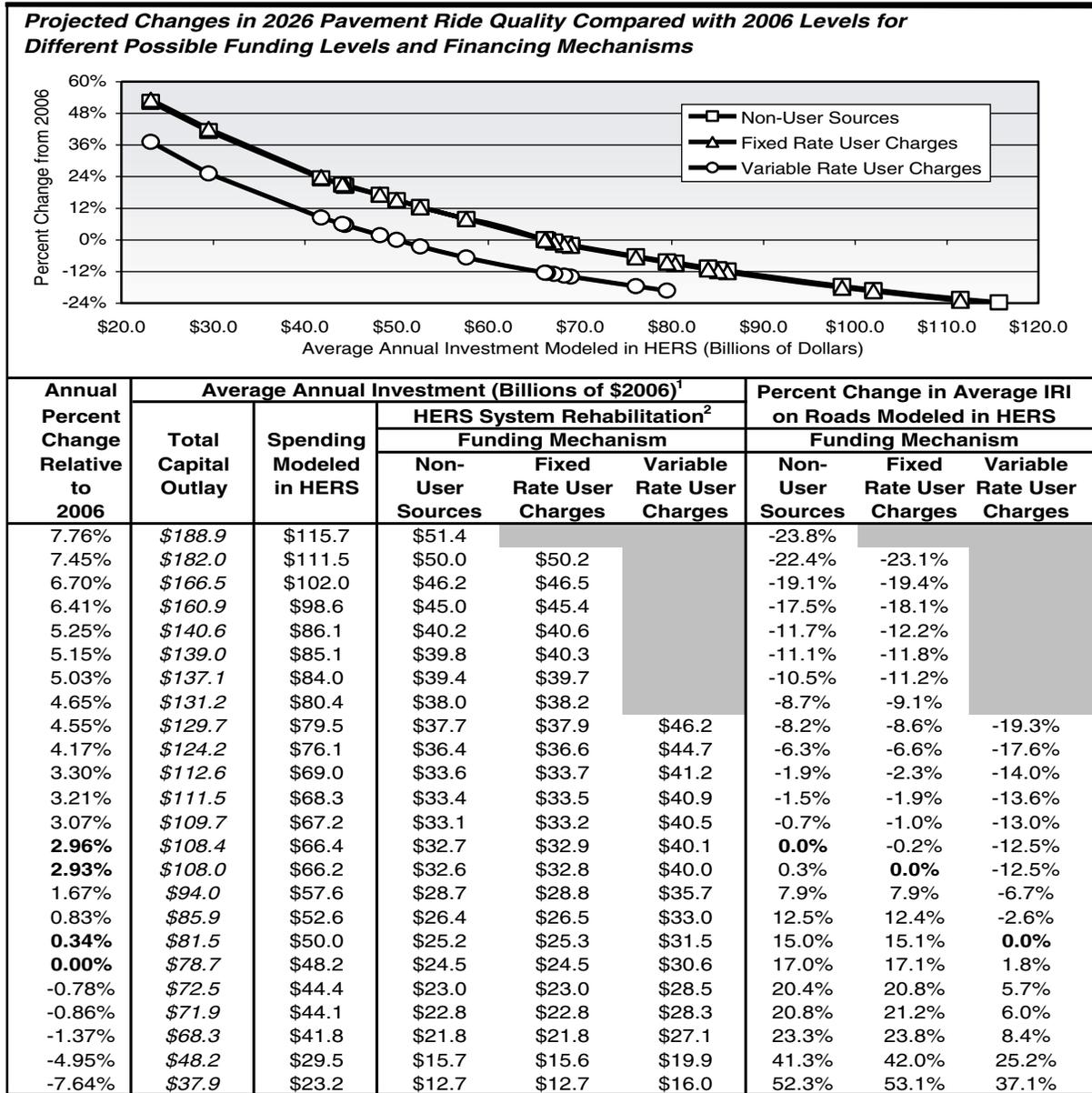
Source: Highway Economic Requirements System, FHWA.

Figure 3.5. Relationship between alternative investment levels and delay from the 2008 C&P.

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gestion delay and incident congestion delay. The table relates projected annual growth rates in constant dollar investments from particular types of fees (non-user, fixed per mile user, and variable per mile user) to the outcomes for the system in terms of the performance measures of the percentage changes in total 2026 congestion delay and incident related congestion delay, compared to 2006 parameters, which provide highly

useful information about the impacts of alternative future highway investment strategies.

Figure 3.6 provides similar information with regard to pavement performance measures as a function of investment levels, also by various types of source of funds. In this case, the fixed-rate user charges and the non-user charges are so close that although they are numerically different the level of detail

Projected Changes in 2026 Pavement Ride Quality Compared with 2006 Levels for Different Possible Funding Levels and Financing Mechanisms

Annual Percent Change Relative to 2006	Average Annual Investment (Billions of $2006)[1]					Percent Change in Average IRI on Roads Modeled in HERS		
	Total Capital Outlay	Spending Modeled in HERS	HERS System Rehabilitation[2]					
			Funding Mechanism			Funding Mechanism		
			Non-User Sources	Fixed Rate User Charges	Variable Rate User Charges	Non-User Sources	Fixed Rate User Charges	Variable Rate User Charges
7.76%	*$188.9*	$115.7	$51.4			-23.8%		
7.45%	*$182.0*	$111.5	$50.0	$50.2		-22.4%	-23.1%	
6.70%	*$166.5*	$102.0	$46.2	$46.5		-19.1%	-19.4%	
6.41%	*$160.9*	$98.6	$45.0	$45.4		-17.5%	-18.1%	
5.25%	*$140.6*	$86.1	$40.2	$40.6		-11.7%	-12.2%	
5.15%	*$139.0*	$85.1	$39.8	$40.3		-11.1%	-11.8%	
5.03%	*$137.1*	$84.0	$39.4	$39.7		-10.5%	-11.2%	
4.65%	*$131.2*	$80.4	$38.0	$38.2		-8.7%	-9.1%	
4.55%	*$129.7*	$79.5	$37.7	$37.9	$46.2	-8.2%	-8.6%	-19.3%
4.17%	*$124.2*	$76.1	$36.4	$36.6	$44.7	-6.3%	-6.6%	-17.6%
3.30%	*$112.6*	$69.0	$33.4	$33.7	$41.2	-1.9%	-2.3%	-14.0%
3.21%	*$111.5*	$68.3	$33.4	$33.5	$40.9	-1.5%	-1.9%	-13.6%
3.07%	*$109.7*	$67.2	$33.1	$33.2	$40.5	-0.7%	-1.0%	-13.0%
2.96%	*$108.4*	$66.4	$32.7	$32.9	$40.1	**0.0%**	-0.2%	-12.5%
2.93%	*$108.0*	$66.2	$32.6	$32.8	$40.0	0.3%	**0.0%**	-12.5%
1.67%	*$94.0*	$57.6	$28.7	$28.8	$35.7	7.9%	7.9%	-6.7%
0.83%	*$85.9*	$52.6	$26.4	$26.5	$33.0	12.5%	12.4%	-2.6%
0.34%	*$81.5*	$50.0	$25.2	$25.3	$31.5	15.0%	15.1%	**0.0%**
0.00%	*$78.7*	$48.2	$24.5	$24.5	$30.6	17.0%	17.1%	1.8%
-0.78%	*$72.5*	$44.4	$23.0	$23.0	$28.5	20.4%	20.8%	5.7%
-0.86%	*$71.9*	$44.1	$22.8	$22.8	$28.3	20.8%	21.2%	6.0%
-1.37%	*$68.3*	$41.8	$21.8	$21.8	$27.1	23.3%	23.8%	8.4%
-4.95%	*$48.2*	$29.5	$15.7	$15.6	$19.9	41.3%	42.0%	25.2%
-7.64%	*$37.9*	$23.2	$12.7	$12.7	$16.0	52.3%	53.1%	37.1%

[1] The amounts shown represent the average annual investment over 20 years that would occur if annual investment grows by the percentage shown in each row in constant dollar terms. The performance impacts identified in this table are driven by spending modeled in HERS; the figures for "Total Capital Outlay" are included to reflect other spending not modeled in HERS.

[2] The amounts shown represent the portion of spending that HERS directed towards system rehabilitation rather than system expansion, which varies depending on the funding mechanism employed.

Source: Highway Economic Requirements System.

Figure 3.6. Relationship between alternative investment levels and pavement quality from the 2008 C&P.

of the graph in the exhibit shows them as nearly similar. Both Figure 3.5 and Figure 3.6 show logical relationships between investment levels and performance which can be used directly in informing target-setting. The important caveat is that HERS and all other models are not direct reflections of future agency investments at particular funding levels.

Figure 3.7 shows the relationship between bridge investment levels and the backlog measures which are commonly used to relate bridge investment to future bridge conditions. Bridges are either termed to be deficient or not deficient (rather than being measured with a sliding numerical scale of degree of deficiency).

FHWA's analysis for the C&P exhibits and the discussion are fully sufficient to inform any target-setting for highway and bridge investments. However, both the HERS and NBIAS models, and the measures they support, are oriented to those investments which are modeled and to the performance measures which are addressed. These include measures related to physical asset conditions, and for HERS, those measures related to user costs, congestion and delay, and congestion and delay costs. NBIAS covers only bridges, and although it includes estimates of impacts on user costs, the lack of information in NBIAS related to highways connecting to the bridges makes it impossible to estimate the user cost impacts of bridge improve-

Projected Changes in 2026 Bridge Investment Backlog on the NHS Compared With 2006 Levels for Different Possible Funding Levels

Annual Percent Change Relative to 2006	Average Annual Capital Investment (Billions of 2006 Dollars) [1]			2026 NHS Bridge Backlog [2] (Billions of 2006 Dollars)	Percent Change in Bridge Backlog Compared to 2006
	Total Capital Outlay	Spending Modeled in NBIAS			
		Total	On NHS		
5.15%	$139.0	$17.9	$7.7	**$0.0**	-100.0%
5.03%	$137.1	$17.6	$7.6	$1.3	-97.4%
4.65%	$131.2	$16.9	$7.4	$5.3	-89.6%
4.55%	$129.7	$16.7	$7.3	$6.2	-87.8%
4.17%	$124.2	$16.0	$7.1	$10.1	-80.1%
3.30%	$112.6	$14.5	$6.5	$18.4	-63.8%
3.21%	$111.5	$14.4	$6.5	$19.4	-61.8%
3.07%	$109.7	$14.1	$6.4	$20.9	-58.9%
2.96%	$108.4	$14.0	$6.3	$22.4	-55.9%
2.93%	$108.0	$13.9	$6.3	$22.6	-55.5%
1.67%	$94.0	$12.1	$5.6	$34.5	-32.1%
0.83%	$85.9	$11.1	$5.1	$42.4	-16.5%
0.34%	$81.5	$10.5	$4.9	$46.0	-9.4%
0.00%	$78.7	$10.1	$4.8	$48.2	-5.1%
-0.78%	$72.5	$9.3	$4.5	$54.1	6.5%
-0.86%	$71.9	$9.3	$4.5	$54.6	7.5%
-1.37%	$68.3	$8.8	$4.3	$57.8	13.8%
-4.95%	$48.2	$6.2	$3.2	$78.4	54.3%
-7.64%	$37.9	$4.9	$2.5	$91.1	79.3%
Cost to Maintain: [3]			$4.7	**$50.8**	**0.0%**
2006 Spending: [4]			**$4.3**	**$57.3**	12.8%
2006 Baseline Values:			**$4.3**	**$50.8**	

[1] The amounts shown represent the average annual investment over 20 years that would occur if annual investment grows by the percentage shown in each row in constant dollar terms. The performance impacts identified in this table are driven by portion of NBIAS-modeled spending on the NHS.

[2] The amounts shown do not reflect system expansion needs; the bridge components of such needs are addressed as part of the HERS model analysis.

[3] The amount shown is projected to be sufficient to maintain the economic bridge backlog at its baseline 2006 level.

[4] The amount shown reflects actual capital spending by all levels of government on NHS bridges in 2006.

Source: National Bridge Investment Analysis System.

Figure 3.7. Relationship between alternative investment levels and bridge investment backlog from the 2008 C&P.

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Table 3.3. Emerging state and local tools for development of performance strategies.

Goal Area	Emerging State and Local Tools
Safety	SHSP process that has emerged over the last few years is an excellent base from which to launch performance analysis, while benefit/analysis can support project-level investment decisions within and across safety related plans and programs, including the STIP, HSIP, Highway Safety Performance Plan (HSPP), Commercial Vehicle Safety Plan (CVSP), and others.
System Preservation	Asset management systems for pavement and bridge apply benefit to analyze and develop improvements in Federal and some state programs, and are probably the most mature systems among the states for developing investment strategies.
Mobility/Congestion	The congestion management process that originated with ISTEA for TMAs and was extended by SAFETEA-LU provides an excellent base from which to develop benefit and investment strategies for this goal. It will require integration of congestion management systems with benefit procedures such as are used in the Intelligent Transportation System Data Analysis System (IDAS). IDAS has not been widely used to date.
Freight/Economic Growth	The Freight Analysis Framework and state-specific freight plans (and freight models) are in an evolutionary stage and are not widely used at this point for investment/analysis, but these could be enhanced towards a more comprehensive freight and economic growth performance framework which utilizes benefit.
Environment and Community	Environmental Management Systems offer good promise for this goal area but are clearly in an early evolutionary stage in regard to investment/analysis.

ment actions. For example, information on whether or not adjacent highways are improved is needed to estimate whether bridge improvements (for example, widening a bridge to have more capacity) would have an impact on levels of service.

For FHWA or for the national level, there are no current economic models or management systems which are used for informing target-setting for the safety, environmental, or freight/economic performance measures. As economic, safety, and environmental modeling methods and procedures are developed in these areas, they can be used for national target-setting and potentially adapted for target-setting at states or MPOs. Table 3.3 identifies the emerging state and local tools.

At the state level, current asset management systems for pavements and bridges are used by many states to inform performance targets and could be more broadly applied.

Usefulness of Current Economic Models and Management Systems in Tradeoff Analysis

While a detailed description of tradeoff analysis is beyond the scope of this paper, it is nonetheless important to note that the concept of "tradeoffs" summarizes the main challenge facing transportation agencies; there are more needs then resources available to address them. In this environment agencies must continually make difficult decisions on which areas of the transportation network to focus their limited resources. Transportation is often a zero-sum game, so additional investment in one area means that an agency must invest less in another.

Guidance on the role of tradeoff analysis in the transportation planning process was initially developed through NCHRP Project 08-36 (Task 07).[5] This project report described the use

of "what if" scenarios in helping agencies understand the implications of different funding options. For example, what would be the impact on pavement performance if pavement funds are increased by 10 percent over the next 10 years? What would be the impact on bridge performance if this money was shifted from the bridge program? In the context of the overall performance management framework, this type of analysis can help agencies establish relative priorities, set targets, allocate resources, and better manage stakeholder expectations.

As with the discussion of target-setting, this discussion of tradeoff analysis addresses the system or program level rather than the project level. Tradeoff analysis also is useful in selecting among project alternatives. To conduct system level or program level tradeoff analysis, an agency must have the results of economic models or management systems or other estimates for the relationships between investments of particular types and the performance measures to be impacted.

Few agencies have systematically used the results of their economic models and management systems for tradeoff analysis. A recent pioneering example is the Detroit metropolitan area's Southeastern Michigan Council of Governments (SEMCOG) which utilizes HERS, asset management systems, and other sources to develop relationships between investment levels and performance measures for a wide range of programs.[6] It then graphically presents the results in a manner which

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[5]Cambridge Systematics, *Development of a Multimodal Tradeoffs Methodology for Use in Statewide Transportation Planning,* developed as part of NCHRP 08-36 (Task 07), November 2001.

[6]Guerre, Joseph and Evans, Jennifer, "Applying System-Level Performance Measures and Targets in Detroit's Metropolitan Planning Process," January 2010.

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Table 3.4. Measures of effectiveness used in SEMCOG prioritization process.

Program Area	Measures of Effectiveness
Pavement Preservation	Percent of pavement in good or fair condition
Highway Capacity	Hours of congestion delay per 1,000 vehicle miles traveled
Bridge Preservation	Percent of bridges in good or fair condition
Safety	Fatalities per 100 million vehicle miles traveled
Transit	Extent of the transit network (the existing network or the region's transit vision)
Nonmotorized	Percent of population and employment within ½ mile of a nonmotorized facility
Roadway operations	Not applicable

Source: SEMCOG and Cambridge Systematics

would allow decision-makers to address the tradeoffs between investments that achieve alternative levels of performance across different performance goal areas. This is the type of analysis which helps inform the nation, the states, and the regions on how investments in support of various system and performance goals could be traded off against each other.

SEMCOG's investment prioritization process consists of the following steps:

1. Define measures of effectiveness and assess current performance.
2. Analyze the relationship between funding and performance within each program area.
3. Develop funding scenarios (each scenario represents a different way of splitting anticipated funds across the program areas used in the RTP).
4. Present the results of the analysis to decision-makers in a format that enables them to conduct program-level tradeoffs, with the goal of reaching consensus on long-range funding and performance targets for the region.

SEMCOG's LRP is organized by the following program areas:

- **Pavement Preservation**—There are 22,820 miles of public roads in the SEMCOG region. The maintenance, rehabilitation, and reconstruction of these roads falls into the pavement preservation program.
- **Highway Capacity**—The highway expansion program addresses recurring sources of congestion. Work in this area includes widening existing roads.
- **Bridge Preservation**—The bridge preservation program area covers work on the region's 3,560 bridges.
- **Safety**—The work in this program area focuses on improving high-crash locations.
- **Transit**—The transit program covers the maintenance, operations, improvement, and expansion of the region's fixed-route transit network.

- **Nonmotorized**—This program covers the maintenance and expansion of the region's nonmotorized network, which consists of bike paths, sidewalks, roadways that accommodate bike traffic, and other amenities such as bike storage facilities.
- **Roadway Operations**—This program covers traffic operations, studies, and routine maintenance. The bulk of the budget for this program (82 percent) is used for routine maintenance.

To support the new prioritization process, SEMCOG revisited its list of existing measures of effectiveness (MOE) and selected a single measure in each program area for analysis (Table 3.4).

The next step in the process was to analyze each MOE to determine the relationship between future performance and expenditure level. The analysis was first done separately for each MOE. The results were then combined into AssetManager NT so that they could be reviewed and better understood. AssetManager NT is a visualization tool that enables users to explore the performance implications of various resource allocation scenarios. The tool brings together analysis results from multiple decision-support tools (e.g., pavement and bridge management systems) and provides a quick-response "what-if" analysis tool for testing different investment options. AssetManager NT was originally developed through NCHRP Project 20-57, "Analytical Tools for Asset Management," and has subsequently been adopted by AASHTO.[7]

SEMCOG identified discrete funding scenarios which emphasized different themes for investing resources. Figure 3.8 illustrates the results of this process. For each scenario, the figure shows the percent of available funding allocated to each program area and the resulting performance in 2030. It includes the following four scenarios:

[7]Guerre, Joseph and Jennifer Evans, "Applying System-Level Performance Measures and Targets in Detroit's Metropolitan Planning Process," January 2010.
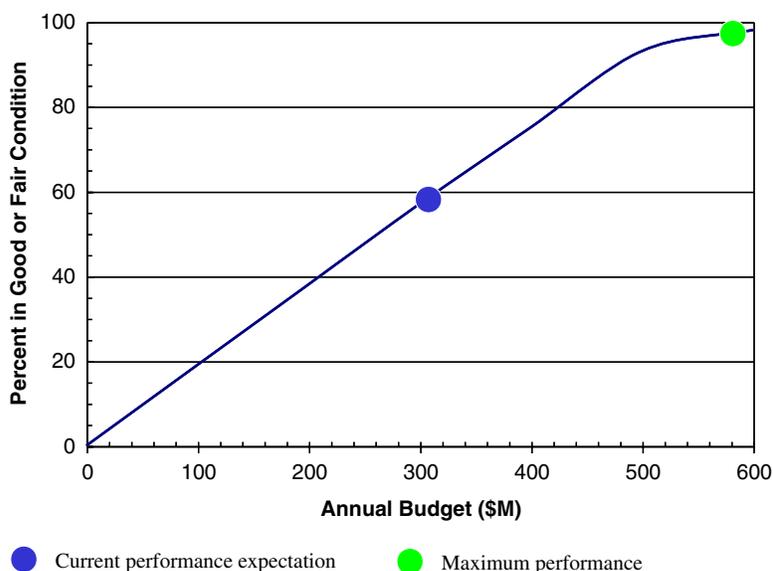
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Program Area	Measure of Effectiveness	Projected 2010	1. Current Allocation		2. Public Opinion		3. Preservation First		4. Transit First	
			2030 Target	Funding Split	2030 Target	Funding Split	2030 Target	Funding Split	2030 Target	Funding Split
Transit	System extent	Current System	Current System	21%	< Current System	12%	< Current System	21%	Transit Vision	41%
Pavement	% pavement in good or fair condition	57%	57%	21%	49%	18%	85%	31%	40%	14%
Bridge	% bridges in good or fair condition	85%	100%	6%	100%	7%	85%	3%	80%	3%
Expansion	hours of congestion delay per 1,000 vehicle miles traveled	2.9	2.6	10%	2.6	10%	3.0	2%	3.0	0%
Safety	fatalities per 100 million vehicle miles traveled	0.77	0.74	0%	NA	7%	0.73	1%	0.73	1%
Nonmotorized	% pop. and emp. within ½-mile of nonmotorized facility	13%	44%	1%	100%	5%	44%	1%	13%	0%
Roadway Operations	NA			41%		41%		41%		41%

Source: SEMCOG and Cambridge Systematics.
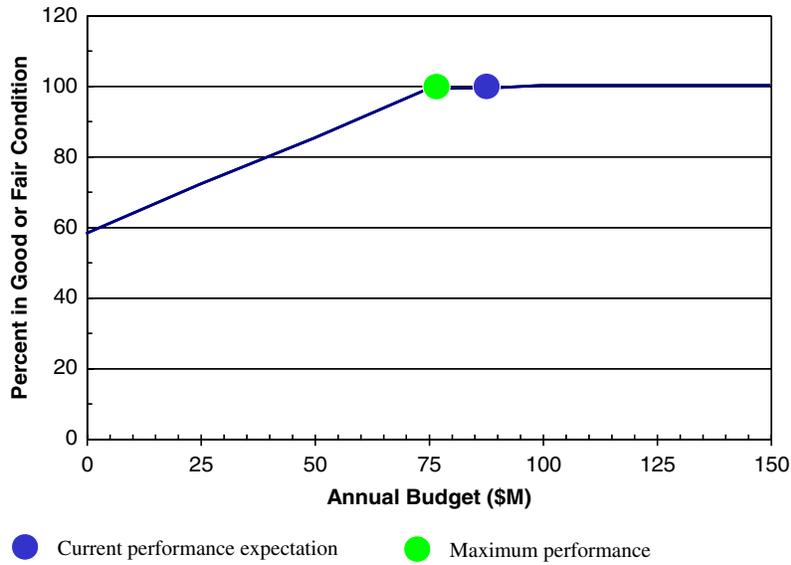
Figure 3.8. Funding scenarios with targets.

1. **Current Allocation.** This scenario represents the funding split from SEMCOG's existing regional transportation plan.
2. **Public Opinion.** The funding splits in this scenario are based on the results of a recent public opinion survey in which respondents were asked how they would allocate $100 among the program areas.
3. **Preservation First.** In this scenario a target of 85 percent in good or fair condition is set for pavements and bridges. The remaining funds are then spread among the other program areas.
4. **Transit First.** In this scenario the entire transit vision is funded. The remaining funds are then spread among the other program areas.

After producing results for each program and scenario and for the alternative funding levels, the information was assembled in a manner which illustrated what level of performance results the region would achieve at alternative funding levels for each of the program areas. These results that inform the trade-off analysis are shown in Figures 3.9 through 3.13.
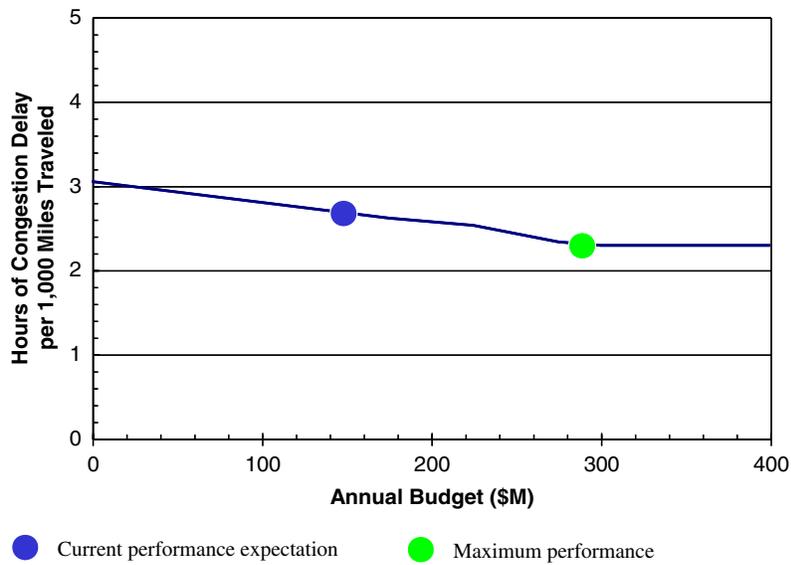

Current performance expectation   Maximum performance

Source: SEMCOG and Cambridge Systematics.

Figure 3.9. Pavement performance versus funding.

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Current performance expectation   Maximum performance

Source: SEMCOG and Cambridge Systematics.

Figure 3.10. Bridge performance versus funding.

Current performance expectation   Maximum performance

Source: SEMCOG and Cambridge Systematics.

Figure 3.11. Delay versus funding.

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Current performance expectation   **Maximum performance**
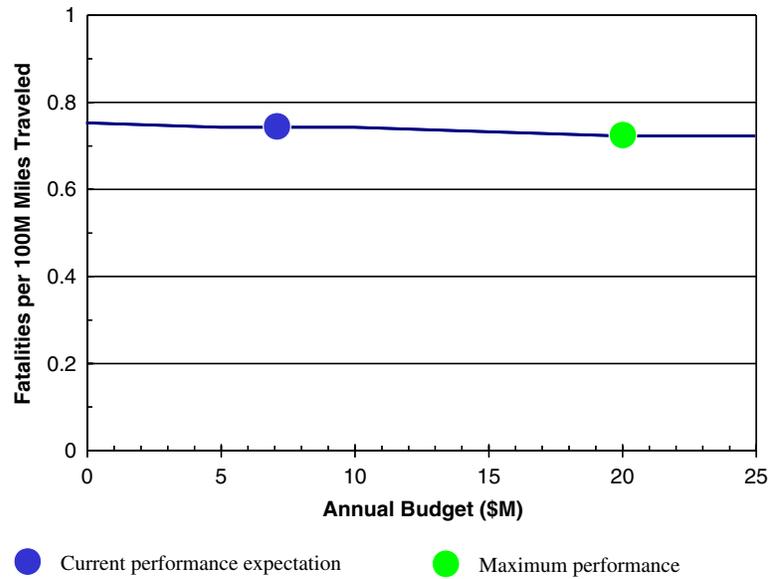
Source: SEMCOG and Cambridge Systematics.

Figure 3.12. Fatality rate versus funding.

Current performance expectation   **Maximum performance**
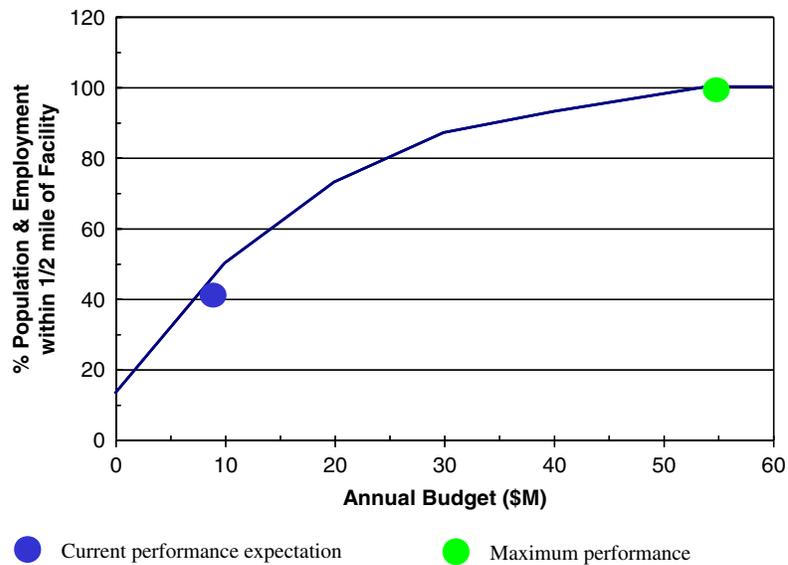
Source: SEMCOG and Cambridge Systematics.

Figure 3.13. Nonmotorized performance versus funding.

After presenting these graphs, SEMCOG also presented the prepackaged scenarios illustrated in Figure 3.8. Members of the Transportation Advisory Council and Executive Committee were then asked to review the scenarios and to do the following:

- Indicate their most preferred scenario;
- Indicate their second most preferred scenario; or
- Fill out a new scenario with preferred funding targets for each program area.

The SEMCOG analysis provides a blueprint for using available economic models and management systems and other procedures to progress through target-setting and through a tradeoff analysis for the types of performance measures that were recommended in the overall performance management framework.

SEMCOG provides an excellent example of the use of tradeoff analysis in decision-making; however, future research should likely focus on how agencies could implement trade-offs into their performance management processes.

3.5 Topic Areas for Volume II Guidance

The previous sections have described how the public and private sectors identify and use performance targets. Based upon these practices, six steps outlined in Volume II of this report provide guidance for state DOTs on how to set and use performance targets. The steps include the following:

- Establish Performance Management Framework;
- Evaluate the Factors Influencing Target-Setting;
- Select the Appropriate Approaches for Target-Setting;
- Establish Methods for Achieving Targets;
- Track Progress Towards Targets; and
- Adjust Targets Over Time.

CHAPTER 4

Data Stewardship and Management

Quality data are the foundation of performance management. Effective decision-making in each element of the performance management framework requires that data be collected, cleaned, accessed, analyzed, and displayed. The organizational functions that produce these requirements are called data management systems. There are two key dimensions to creating and sustaining these systems. The two areas are equally important and must be synchronized within an organization to ensure the generation and use of accurate, timely, and appropriate data. The first area centers on the technical challenges associated with data systems, including development and maintenance of hardware and software, and the specifications for data collection, analysis, archiving, and reporting. The second area focuses on the institutional issues associated with data stewardship and data governance. Attention to both of these areas is required to assure solid data management systems.

Research for this project included an investigation of the ways data management systems and organizational units within a DOT are used to integrate data for purposes of ensuring the use of accurate, timely, high-quality data for decision-making purposes. The research focused on both technical and institutional solutions and best practices. This section summarizes the findings of the case studies in Volume III and includes many specific and relevant examples to demonstrate how data programs are supporting decision-making in many private and public sector agencies.

4.1 Introduction

The term data program in this report refers to specific data systems that support a business area of the organization. The "program" usually includes the functions of data collection, analysis, and reporting. In the case of a DOT, some examples of these programs include traffic, roadway inventory, safety, and pavement data.

In many organizations, including some DOTs, targets are used to measure how well programs are performing. The process to develop targets is, in many cases, based on historical trends. It is often challenging to develop the most-effective targets for assessing how well a program is performing, and using past performance is a good basis as a starting point. More research is needed to investigate the analytical tools that are available for developing targets that most effectively measure program performance in a specific business area. Establishing targets and developing data programs both rely on one basic component, data.

Data must be collected, processed, and distributed through a means accessible to decision-makers at all levels of an organization. Data are the basic pieces of information which when processed through a system are available for analysis. The core data pieces transform into information and decision-makers then use this information to manage business areas across the organization. In order for data to effectively meet the needs of the organization, it should be assessed in terms of accessibility, accuracy, completeness, credibility, timeliness, and associated risks. A data risk assessment and management plan is often used to identify potential and known risks, assign persons and offices responsible for handling the risks, and for developing risk mitigation plans. Using a risk management plan strengthens the overall data management program within the organization. More information on the assessment process and data management is discussed in the following sections of this report.

Within any organization, data serves as the critical link between business areas of the organization. In a DOT, these areas often include operations, planning, and production. Typical office functions within Planning include long-range planning, policy planning, and traffic data collection. Operations often include traffic engineering, safety, and maintenance functions. Production refers to construction within a DOT. There are some similarities and differences in the types of data which are used to support each of these areas. Operations, planning, and production functions often also rely on Human Resource type data, including available staffing for

particular projects and financial data for projections of available funding.

The similarities and differences of the types and needs for data are best managed within a data management framework, which includes data standards, definitions, policies, and procedures for how data are to be collected, processed, and used within the organization.

More recently, data and performance measurement programs that support operations and the link between operations and planning in state DOTs are becoming more prevalent. This need is driven by several factors, including increases in congestion nationwide, an increasing emphasis on safety and environmental factors along with a reduction in resources, and the inherent need to keep the transportation system operating efficiently. In addition, technology to generate, archive, and analyze transportation data along with the increasing number of private data sources suggests a need to harness and leverage the information.

Also recent legislation from the Federal government and state legislatures places an increasing emphasis and responsibility on states to be accountable to the citizens for their expenditures. Performance management is one of the ways in which DOTs are responding to this need. A lot of the data and information needed for performance management is available through the planning division of a DOT. This includes data on the extent, condition, and performance of the transportation network in the state. A strong performance-based management program, such as the one adopted at the Mn/DOT, helps that agency to align its strategic goals with its business and supporting data programs in order to best meet the needs of the citizens of Minnesota.

It is this link of performance measurement data which supports planning, operations, and all areas of a DOT that is the subject of the remainder of this chapter. This report will examine the ways in which data systems are linked to performance measures in order to support stronger incentives for agency leaders to invest in their data programs as strategic assets and to allocate resources using a performance-based management approach.

The material in this chapter of the report is organized in the same order as the survey instrument used for the case studies. The sections are in the following order:

- 4.2 Elements of Effective Data Stewardship and Management,
- 4.3 Organization and Governance,
- 4.4 Data Sharing,
- 4.5 Documentation and Reporting,
- 4.6 Technology,
- 4.7 Relationships to Target-Setting and Resource Allocation, and
- 4.8 Summary of Success Factors and Obstacles.

The discussions in each section refer to the case studies found in Volume III.

4.2 Elements of Effective Data Stewardship and Management

This section examines the institutional impact of implementing data stewardship and governance in an organization. Figure 4.1 illustrates the hierarchical relationship between data management, data governance, and data stewardship.
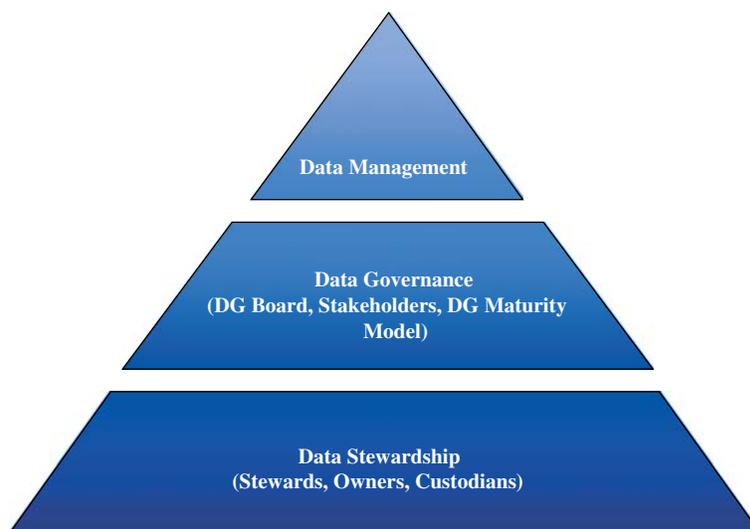
Source: Modified from Figure 1 Data Governance Team, The Data Governance Maturity Model. White Paper, RCG Information Technology, 2008.

Figure 4.1. Data management, data governance, and data stewardship.

The examples in this section illustrate how some DOTs and other public or private sector organizations have defined these terms.

The data governance role primarily represents the individuals responsible for establishing overall policies, standards, and procedures that are to be followed by the organization. The data stewardship role represents the team of individuals throughout the organization who are responsible for enacting these policies and procedures on a daily basis. The data management program can be considered the umbrella overseeing all activities related to the management of core data systems.

Data management can be defined as the development, execution and oversight of architectures, policies, practices, and procedures to manage the information lifecycle needs of an enterprise in an effective manner as it pertains to data collection, storage, security, data inventory, analysis, quality control, reporting, and visualization.

Data governance can be defined as the execution and enforcement of authority over the management of data assets and the performance of data functions. The management of data assets for an organization or state DOT is usually accomplished through a data governance board or council. This role is critical in successfully managing data programs that meet business needs and in supporting a comprehensive data business plan for the organization. More information on data governance is included in Section 4.3.

Data stewardship can be defined as the formalization of accountability for the management of data resources. Data Stewardship is a role performed by individuals within an organization known as data stewards. For example, the Data Stewards as defined by the Kansas State Department of Education (KSDE) are the individuals who manage the definition, production, accountability, and usage of data.

Some of the duties of the data stewards at KSDE include the following:

- Provide data analysis related to individual specific program area;
- Regularly evaluate the quality of the data;
- Identify opportunities to share and re-use data;
- Enforce data quality standards;
- Communicate business needs for data security; and
- Communicate criteria for archiving data.

In addition to Data Stewards for individual data programs, such as traffic, roadway inventory, safety, and pavement data, DOT also may have enterprise Data Stewards who are responsible for maintaining the enterprise data warehouse. Their roles and responsibilities are similar to those just described, but, on a much larger scale.

The RCG Information Technology Company further identifies two categories of data stewards. One is the day-to-day steward who has the responsibility and authority to make decisions about data for a given system and the other is the issues/practices stewards who are usually the supervisors or operational technicians responsible for securing the data or using the data for high-level decision-making.

WSDOT has defined roles for Business Stewards and Technical Stewards, as well as other steward roles who ensure that standardization is used in the collection, storage, integration, and reporting of data in order to meet business needs. Using defined roles for business and technical stewards, WSDOT recognizes the importance of building a partnership between the business and information technology segments of the department, which helps to sustain a robust data governance framework beyond changes in administration.

In addition to data stewards, there also are Data Work Groups and Communities of Interest groups (COI) associated with the support and/or use of data in an organization. The Alaska Department of Transportation and Public Facilities (ADOT&PF) Program Development Division defines these two groups in the following way:

- Data Work Groups (DWG) includes the association of people who collect and provide data for specific data programs and who establish business process rules for a specific system. The DWG make recommendations to the data governance council on the development or enhancements to data programs which support business operations of the agency and/or the Program Development Division.
- Each Community of Interest represents an association of people with a common interest as users of a specific data system. In the case of Alaska, the COIs include representatives from internal business areas and external entities and provide input through outreach and communication with the Program Development Division on the data and information needs regarding specific data programs.

The role of data ownership also is an important part of the data governance framework. Data owners are somewhat different from the data stewards. While data stewards traditionally have day-to-day responsibility for ensuring quality data is available from a particular system and for managing the definition, production, and usage of the data, data owners have a higher-level of responsibility to ensure the protection of the data and authorize access to various data applications in their business area.

In a public agency such as a DOT, the divisions or offices of the DOT may serve as data owners for specific applications supporting their business area, such as planning, traffic operations, and engineering. For example, FDOT has an established policy that clearly delineates the responsibilities of the IT division versus the office data owners. Custodians and owners outside of the IT department are responsible for

ensuring that sufficient controls are established within their area of responsibility to ensure the accuracy and completeness of data and that data comes from the appropriate source for the intended use.

In private sector companies, any group, other than the IT department, does not typically own data. Some private sector organizations also have performance measurement groups whose responsibility includes data ownership.

To clarify the definitions and roles and responsibilities for stewardship and data management within a DOT, Mn/DOT has developed the following draft definitions as part of their overall development of a Data Business Plan for the Department:

- **Data Management** Data management is the development, execution, and oversight of architectures, policies, practices, and procedures to manage the information lifecycle needs of an enterprise in an effective manner as it pertains to data collection, storage, security, data inventory, analysis, quality control, reporting, and visualization.
- **Data Custodians** Data custodians are the information technology professionals responsible for the maintenance and security of databases, hardware, and software used to support application systems.
- **Data Owner** Data owner is a role or group who is empowered to make decisions about how a data entity can be structured, manipulated, or used.
- **Data Stewards** Data stewards are individuals accountable for the accuracy, integrity, and timeliness of the data as well as for informing users of the appropriate use of data.
- **Data Stewardship** Data stewardship is the formalization of accountability for the management of data resources.
- **Data Users** Data users are the individuals who have authorized access to retrieve data from information systems to conduct business.

A more detailed discussion of how the public and private sector have integrated these roles into their organizations follows in Section 4.3.

4.3 Organization and Governance

There are a variety of data governance models which can be used by organizations to develop their own data governance framework. Each model has its own advantages and disadvantages. The main concept to keep in mind is that there is not a one-size-fits-all approach when developing a data governance framework and each agency should develop a model that best suits the needs of the organization. This section discusses some of the various models that have been used for developing data governance and the associated data stewardship roles and responsibilities.

There are institutional issues, as well as technical challenges, in any organization considering implementing data stewardship and data governance. Using a well-defined data governance model helps to ensure successful sharing of responsibilities with respect to data management functions. A data governance board or council can be established to serve in the oversight role for managing the data governance activities of an organization. The members of this group are usually high-level managers and executives of the agency or company. Likewise, there are corresponding data stewardship roles defined with responsibility to collect, maintain, and use data in accordance with the policies instituted by the board.

In many cases, data also are recognized as a valuable asset in both the public and private sector and therefore, agencies allocate a certain portion of their budgets to the proper management of data programs and to securing and protecting the integrity of the data systems within the organization. Protecting and securing of data systems includes establishing access to the systems using authorized login and password procedures, and establishing back-up and recovery procedures for data applications and databases.

Investments in data programs in the private sector are primarily judged on a cost/benefit basis. If the cost of an upgrade project cannot be justified on the savings it will bring, it does not proceed. Departments must carefully demonstrate the return on investment (ROI) to senior executives to gain support for development or continued use of various programs.

This also is true in the case of a DOT that must often demonstrate the value of a given program to the state legislature or the public, who sustains these programs through their tax dollars. For example, the underlying data programs that support performance measures at Washington DOT were critical in convincing the State legislature to continue investments in a fish barrier removal program versus other programs that may have a higher legislative priority.

Figure 4.2 illustrates the important link between an agency or company's strategic mission and goals and the data governance framework that is in place to manage the data programs to ensure that the highest quality data are available in a consistent and timely manner to support core business functions in all areas of the organization.

The data users and stakeholders as well as the data stewards and custodians each serve a critical role in developing and maintaining data systems, which meet user needs. To have a well functioning data governance structure, there must be open channels of communication between the providers of data and information and the users of the data. Outreach programs from the data providers to the data user community are an effective way to maintain this relationship.

The benefits of implementing a data governance framework include improved quality of data collected and reported, which in turn, has a positive impact on decision-making. Figure 4.3

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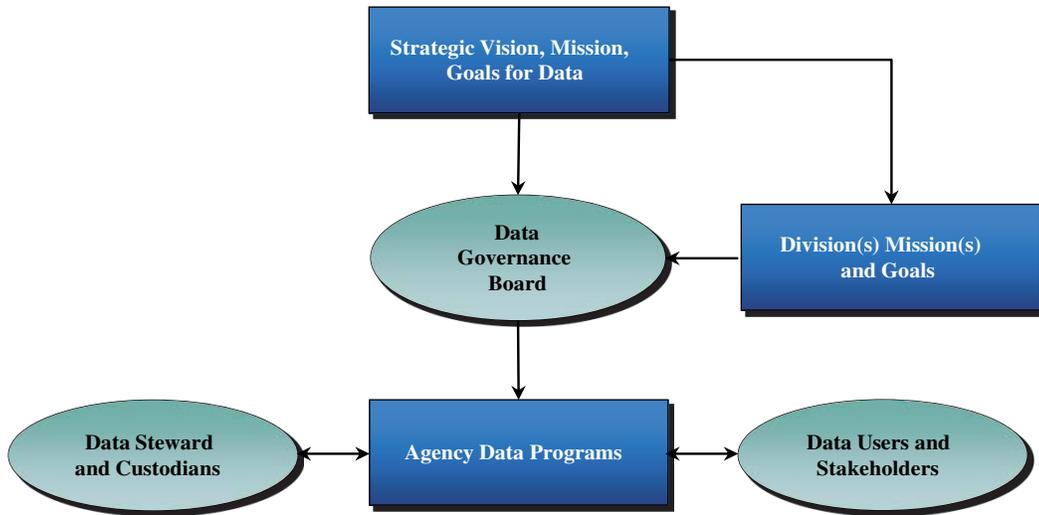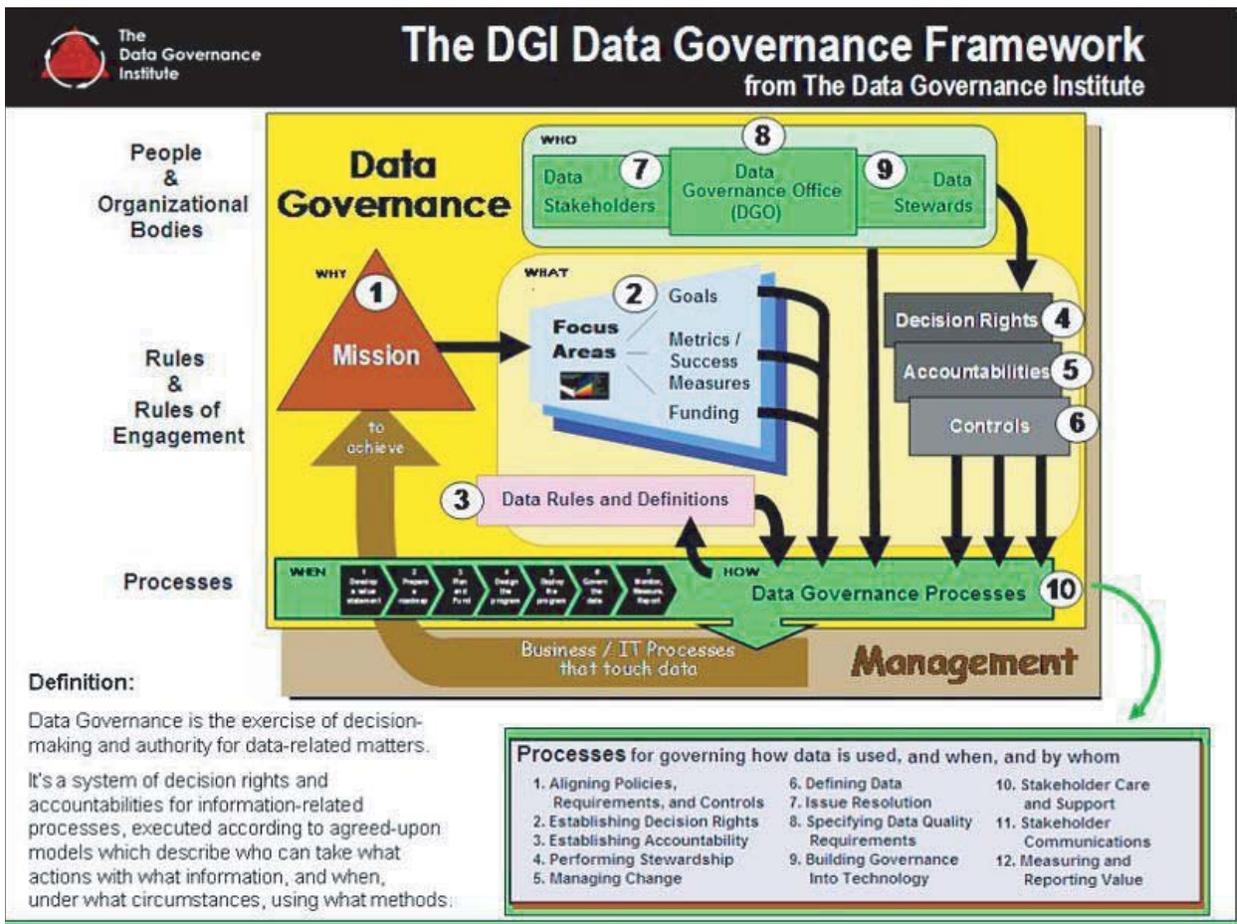
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Figure 4.2. Overview of a general data governance framework.

Source: www.Datagovernancesoftware.com.

Figure 4.3. Example data management structure.

shows an example of a potential data governance framework. It shows each of the 10 universal components of a Data Governance program. Regardless of the focus of a data program, it will include each of these components to some extent, although the emphasis of each component will vary according to the program's objectives.

One way to organize these components is by looking at why the program exists, what it is doing, who is involved in the efforts, and how they are performing processes to provide value to the organization. Another way to look at a Data Governance program is to consider the following:

- The rules that the program is making (such as policies, requirements, standards, accountabilities, and controls) and the rules of engagement that describe how different groups work together to make those rules and enforce them;
- The people and organizational bodies involved in making and enforcing those rules; and
- The processes that these people follow to govern data, while creating value, managing cost and complexity, and ensuring compliance.

In general, private sector companies do not use data governance protocols or explicit standards covering data parameters, data cleanliness, or data revisions. However, they are often experts at sharing data between business units and across companies. There are several different models and combinations of data governance approaches. Some examples along with advantages and challenges are discussed in the following sections.

Washington State Department of Transportation (WSDOT)

Several public sector organizations have been proactive in implementing some type of data governance framework or are in the process of doing so. WSDOT has a Data Council and a Data Stewardship Council to help support data governance at WSDOT. WSDOT also further defines two categories of Data Stewardship: Business Stewardship and Technical Stewardship. The Business Stewards are executive, managerial, and operational stewards, while the Technical Stewards include the more traditional roles of system architects and database administrators. While these roles may be defined for larger application systems, WSDOT does acknowledge that for smaller applications there may be just one or two people responsible for maintaining a specific data system, and there is no formal stewardship role defined for them.

WSDOT Advantages

The WSDOT model started with a smaller goal of gaining support at the executive level for a data policy. This eventu-

ally led to the support for the development of a data catalog which was followed with the development of a Data Stewardship program. This proved to be an effective method for beginning implementation of a data governance framework.

The role of the Data Stewardship Council is to address data issues across the Department. An additional Data Council also was established to set standards for such components as data architecture, data modeling, and data stewardship.

The Department successfully encourages the use of data standards, by linking the funding of various programs, when possible, to the use of those standards within the organization. This is an effective means for gaining compliance with the data management policies and procedures for the Department.

Defining distinct roles for Business and Technical Stewards also serves to strengthen this critical partnership and the overall data governance framework for the Department.

WSDOT Challenges

The WSDOT case study indicates that in some areas there are no formal stewardship roles, and there may only be one or two individuals responsible for supporting a data system. It would strengthen data governance at the Department if all individuals who are performing stewardship roles are clearly identified as such. One method of doing this is by providing their contact information in a Data Catalog, along with the application which they support.

Kansas State Department of Education (KSDE)

KSDE, like DOTs, must meet Federal reporting requirements and the development of a data governance framework at KSDE grew out of the need to meet those requirements on an annual basis. There also are clearly defined Federal performance measures that each school district must adhere to in order to continue receiving funding and accreditation. Therefore, the data management policies at KSDE were established to direct the data collection, maintenance, and reporting activities of the department to ensure that performance measures are reported in a consistent, timely manner each year.

KSDE also developed handbooks to support data governance at the department. This includes handbooks for a Data Governance Board, Data Request Review Board, and Data Stewards.

Each handbook includes the following components for each board:

- Mission statement for the board;
- Scope and responsibilities of the board members; and
- Goals and objectives of the board.

KSDE Advantages

There are many advantages associated with the use of the KSDE data governance model. In addition to having a formal Data Governance Board established by an official charter, KSDE also has a Data Request Review Board, which was established to support the flow of data and information requests. This Board approves, prioritizes, and assigns requests related to data and information systems. When the need arises, this Board elevates issues to the Data Governance Board for resolution. There is a clearly defined channel of communication for processing requests and for addressing issues as needed.

KSDE also has developed handbooks for the participants in the data governance structure within the organization. These include handbooks for the Data Governance Board, Data Request Review Board, Data Stewards, and all other KSDE data governance participants. This helps everyone to better understand their role in supporting the overall data governance framework at the agency.

KSDE also involves data stewards in the initial planning stages of system development, as subject matter experts, to ensure that the needs of the organization are met, while the planned project development complies with all standards, definitions, and procedures for use of data at the Department.

KSDE Challenges

The primary challenge at KSDE was in developing a model that suited their needs. To do this, they researched information regarding data governance and attended webinars and presentations to learn more about it. Through this process, they were able to develop a data governance model that best suited their needs. They also have senior-level support for using data governance at their organization which has proven to be an effective management tool for ensuring that their state education programs remain in compliance with Federal requirements for public education.

Hennepin County, Minnesota

Hennepin County considers data governance and data stewardship roles to be shared responsibilities within the county. There is an IT Governance Board, established by an official charter, which is comprised of Department Directors, the Deputy County Administrator, and the County Administrator. The county also has an IT Steering Committee that provides advice on how proposed information systems will fit into the current IT architecture at Hennepin County. Each of the departments in the county are expected to work with staff from other departments in the development of new information systems, while the IT department ensures that the new systems comply with county IT policies and standards.

Hennepin County Advantages

The Hennepin County data governance model has been successful in large part, due to the strong support from the County Administrator for performance-based management. This agency also uses an official charter to empower an IT Governance Board and IT Steering Committee. Establishing such a formal structure serves to strengthen the overall data governance structure for the county. While each department in the county can develop new information systems, each office is expected to coordinate with the IT office to ensure that any new systems comply with overall county IT policies and standards. This provides for a streamlined data management program which effectively meets the needs of all departments within the county.

Hennepin County Challenges

Hennepin County has developed dashboards and scorecards to make it easier for managers to monitor progress in various county programs on a weekly, monthly, quarterly, and annual basis. Since the development of the scorecards is an ongoing process, some departments of the county have scorecards and others do not. The county has acknowledged that there is a need to have a countywide scorecard, and their challenge is to eventually have the ability to review program performance across all departments for the county.

Alaska and Minnesota Departments of Transportation

In some DOTs, such as Alaska and Minnesota, the development of data governance frameworks is just beginning as part of the development/implementation of a Data Business Plan. The roles of data governance and data stewardship will eventually become part of a more structured approach for management of data programs within both of these agencies. Mn/DOT also has established a Business Information Council (BIC) to guide the development of their Data Business Plan, which will ultimately include the implementation of a data governance framework for the department.

Alaska and Mn/DOT Advantages

The advantages of developing a data governance framework at DOTs such as in Alaska and Minnesota are yet to be fully realized, as each of these agencies are in the preliminary stages of defining what their data governance model will look like and how it will be implemented at their respective agencies.

Alaska has taken the approach of developing a data governance model for a specific business area, i.e., planning. Mn/DOT is developing a data governance model for the department as a whole. The commonality between these two approaches is

that they are both being developed as part of a Data Business Plan. Each agency understands the significance of the contributions of its data programs in supporting business operations and is engaging in developing data business plans which will be used to manage the current and future investments in their data programs.

Alaska and Mn/DOT Challenges

Many of the challenges from the Alaska and Mn/DOT examples are shared by other organizations as they begin to develop and implement data governance. There is the need to gain executive-level support for a data governance program. Some agencies are more successful than others in gaining initial executive support. There also is the need to assess the current state of data programs, identify areas where gaps in data and information exist, and prioritize those needs as part of short-term and long-term investment plans for data programs. Depending on the size of the organization and the number of data systems to be assessed, this process can take several months to complete. Identifying Communities of Interest, which are basically the users of the data systems, also is an involved but necessary process to ensure that any data programs developed actually meet user needs.

Ultimately, each DOT will need to design a data governance framework that best meets the business needs of their organization.

Port Authority of New York/ New Jersey (PANYNJ)

The Port Authority of New York/New Jersey (PANYNJ), while acknowledging that there is not an official data governance board or council overseeing the management of its data programs, does have a governance process for considering and approving potential enhancements to data systems which support core business functions. Any requested changes to an existing system from one line department must be considered for potential impact to the other line departments. Any line department wanting an application developed also must coordinate this effort through the IT department.

This example demonstrates the importance of having some type of governing or coordinating function which oversees the development and maintenance of application systems within an agency, whether or not the function resides with the IT department, as it has traditionally in the past, or with the establishment of an official data governance board or council.

PANYNJ Advantages

The data governance example from PANYNJ demonstrates that it is not always necessary to have a complicated data governance structure. If a simpler model meets the needs of the organization and it is just as effective as a more detailed model, then there is no need to overdo the data governance framework.

PANYNJ Challenges

In the PANYNJ example, the responsibility for data governance basically belongs to the IT department. It is important that the other line departments continue to work with the IT department in the development and implementation of any new systems or redesign of existing systems. While this arrangement works well at PANYNJ, it may pose more of a challenge at other organizations.

Each of the previous examples illustrates the importance of developing and implementing a data governance structure that suits the needs and size of the organization. Ultimately, since the success of implementation of data governance relies on a strong partnership between the business offices and the IT office of the agency, it is advisable to engage the IT professionals as early as possible in developing the data governance model for the agency and a corresponding strategy for implementation of the model.

4.4 Data Sharing

One of the key factors in the success of data management programs is having well-defined procedures, methods, and tools for sharing data both internally and externally. Sharing data provides benefits not only in terms of reducing costs associated with having multiple offices collect the same data but also in terms of resources dedicated to maintaining duplicate data systems. Data sharing can reduce the risks of providing different responses to the same question when a single source of data is used for reporting and decision-making in a specific business area, such as data that are used for reporting performance measures for various programs.

In an effort to reduce the cost of data collection, many organizations utilize formal data sharing agreements with external partners and agencies. An example of this type of arrangement is demonstrated in the exchange of data between a DOT and the local police department or division of motor vehicles. The Maryland Motor Vehicle Administration (MVA), for instance, uses Memorandums of Understanding (MOU) with all organizations that it shares data with. Some of the types of data that the MVA obtains from external sources include the following:

- National Driver Register data;
- Social Security data;
- Commercial Drivers License data; and
- Insurance data.

The MVA also shares data with the public, including driving records, vehicle data, and title records.

Three excellent examples of sharing data in the safety arena come from Alaska. Alaska's Multi-Agency Justice Integration Consortium (MAJIC) is an active group whose members include twenty key agencies including the Department of Law and Criminal Division, Association of Police Chiefs, Division of Motor Vehicles, Health and Social Services, Department of Transportation, and Department of Public Safety. Each agency signed a Memorandum of Agreement. The mission is "to help agencies more efficiently share complete, accurate, timely information in order to enhance the performance of the criminal justice system as a whole." They have established measures of data completeness, accuracy, and timeliness. The system used in Alaska for sharing electronic citation and collision data is called Traffic and Criminal Software System (TraCS). TraCS is an automated data collection system that includes electronic ticket and collision forms, DWI forms, arrest and incident forms, commercial vehicle inspection forms, and the use of GPS devices and GIS maps. TraCS increases safety by significantly decreasing the amount of time it takes an officer to write a traffic ticket or collect collision report information; greatly improving the accuracy of collision and ticket data that police collect; reducing the time officers spend on paper work, thus increasing their availability for patrol; and reducing duplicate data entry by police, DMV, and the courts, which saves time and minimizes errors. The third example of successful sharing of safety data is the Alaska Traffic Records Coordinating Committee (ATRCC) which was created to bring people together who are interested in reducing traffic injuries and deaths by improving the timeliness, accuracy and consistency of traffic crash data. The ATRCC meets at least once each month to discuss ongoing and upcoming safety data sharing projects. PANYNJ also has formal data sharing agreements with local police, Federal, and other state government agencies. The Aviation Department of PANYNJ uses data from the FAA databases to integrate with their internal Aviation division applications.

Due to the need to have data on extent, performance, and condition of off-state system or local roads to meet Federal reporting requirements, several agencies use data available from MPOs or cities and counties to integrate into the state road network. In the case of the MTC of the Bay Area in California, there is a requirement that local jurisdictions provide updated pavement condition data to the MTC, or they will not be eligible to receive Federal grant funding. Likewise, each state DOT must submit their annual public road mileage certification to FHWA, as well as the Highway Performance Monitoring System (HPMS) report, or they too risk losing Federal highway funds.

An excellent example of data sharing between a state DOT and external entity comes from the OOCEA regarding the sharing of travel time data with FDOT. FDOT routinely accesses the data and traffic monitoring sites used by OOCEA as part of its oversight responsibilities for the road network in Florida.

The City of Coral Springs, FL, also participates in cooperatives to share comparative and competitive data with others in municipal government. They exchange data with a group of 100 cities nationally to benchmark their performance compared to other cities of similar size. Through this data sharing agreement, they can design ways to improve performance and services provided by the City.

Internal access to data and data sharing is just as critical as having external data sharing arrangements. Internal data are often shared using a data warehouse by using data marts to provide data query, analysis and reporting capabilities. The sharing of metadata to describe the purpose and use of the data also helps to ensure that the correct data are used for making strategic decisions affecting the organization.

Some organizations also support data sharing internally with a Knowledge Management (KM) system, which is an electronic repository of all types of information such as the following:

- Data standards, policies and definitions for all business application data, including metadata;
- Work processes used to support a business program using a specific data system;
- Lessons learned regarding use of IT tools, or other similar data systems;
- Agency or department policy and standards regarding the use of data;
- Reports which monitor the performance of a given data program; and
- Data models for critical data systems.

The use of a KM system allows an organization to do the following:

- Leverage the expertise of people across the organization;
- Manage business environments and allow employees to obtain relevant insights and ideas appropriate to their work;
- Facilitate and manage innovation and organizational learning;
- Make available increased knowledge content in the development and provision of products and services;
- Achieve shorter new product development cycles;
- Increase network connectivity between internal and external individuals; and
- Manage intellectual capital and intellectual assets in the workforce (such as the expertise and know-how possessed by key individuals).

The U.S. Army Armament Research, Development, and Engineering Center (ARDEC) has a Knowledge Management office which is responsible for maintaining historical and current information about armament manufacturing, armament failure reports, and lessons learned. The lessons learned information is very valuable in reducing the learning curve for new engineers.

A similar use of a KM system at the Virginia Department of Transportation (VDOT) has proved to be a valuable source of information on lessons learned, thereby reducing the learning curve for employees who may be new to supporting a specific data program. As part of their Data Business Plan implementation, the ADOT&PF Program Development Division also is investigating the ways in which a KM system can benefit the division and regional offices that support statewide planning programs.

Data sharing, internally and externally, is often done through the use of published monthly or annual reports. For example, the MTC publishes all available data on the Internet and produces an annual State of the System report that includes information on congestion, transit ridership, and regional statistics. A combination of dashboards and scorecards also are used to share data with internal and external departments and agencies as well as the public. The KSDE provides public access to the KSDE Report Card which shows how well the school districts are performing according to national and state standards. Similarly, DOTs use such systems as COGNOS to display dashboard information about the performance of the department in such areas, including safety, traffic operations, engineering, maintenance, and financial information on project costs. The VDOT has such a dashboard available for review by the public. COGNOS is described in more detail in Section 4.5.

Hennepin County also uses COGNOS to display performance measure scorecards for departments throughout the county. This allows managers and staff to monitor performance of vital service programs routinely for the citizens of the county and to address issues as needed when performance is less than the targeted levels. The use of scorecards also is a means to quickly identify where performance targets may need to be adjusted, either up or down, for a given program.

Each of the previous examples illustrate how various agencies use data sharing methods and tools to reduce costs of data collection efforts and improve the decision-making process by providing data in an easily understandable format such as executive-level dashboards or scorecards, or through the use of published reports for internal and external customers. Sharing of information, such as lessons learned and work processes used to maintain data systems, reduces the learning curve for new staff. This results in increased productivity and shorter project development timelines. Ultimately, this can result in cost-savings to the organization. One of the most important benefits, however, is in improving decision-making at all levels of the organization, when information is shared and is easily accessible to everyone.

It also is important to standardize data formats and definitions and to facilitate the integration of data from many separate data sources. Having a single source of data to provide information on a weekly, quarterly, or annual basis greatly improves decision-making at all levels. In the case of a DOT, this standard source of information also sustains credibility with external customers, who include the legislature, other state agencies, the Federal government, and organizations in the private sector as well as the general public.

The purpose of having effective data sharing practices is to provide the highest quality data, which eventually becomes information and then knowledge. It is easier for managers to make decisions in a timely manner when they have the best available information accessible to them. It also is easier for staff to provide the stewardship responsibilities for maintaining critical data systems which support business operations when they have access to knowledge about how the data systems work and how they support the business needs of the organization.

4.5 Documentation and Reporting

There are several ways an organization documents their data systems to provide information and report to managers and policy-makers on-demand. The approaches used for documenting and reporting information vary from group to group.

A state DOT routinely provides reports to the public and the legislature as well as to other Federal, state, or local agencies. The DOTs, therefore, must invest a certain amount of their budget in maintaining needed documentation and generating standard reports on an annual, quarterly, or monthly basis. Standard documentation is traditionally kept in the form of data dictionaries, metadata descriptions attached to data files, and the use of data catalogs. While this responsibility traditionally resides with the IT experts, it is becoming more common for the responsibility to be shared with business units in the organization in order to ensure consistent use of data and business terms throughout the organization.

Both the ADOT&PF Program Development Division and Mn/DOT are investigating ways to store and disseminate metadata information to the decision-makers in their agencies. This includes the establishment of metadata standards and the ability to deliver this information so that policy-makers use the right data systems for making business decisions.

Another component of internal documentation and reporting involves establishing mechanisms for tracking changes to data systems. Change tracking mechanisms help to ensure that the prioritization of requested system changes is in accordance with the primary goals and objectives of the agency. It also is advisable to involve all necessary business units in the discussions regarding system changes which impact multiple business

areas, prior to designing and implementing those changes, to alleviate potential problems in the future. This is the approach used at the PANYNJ where any department-initiated request for changes to an existing system must be coordinated through the IT Department and must involve a review by other line departments to ensure that all impacts are discussed ahead of time.

While determining what type of documentation to maintain and what standards are to be used is important, it is equally important to ensure that the documentation is archived in a repository that is sharable across the enterprise. This is where the use of a KM system, as described in Section 3.4, can provide great benefit to the organization.

The use of an enterprise data warehouse also can provide widespread access to data and information to the organization. A data warehouse using Extract Transform Load (ETL) tools mines data from source databases and loads the data into data marts. The data marts can serve not only as a repository for standard reports but also provide query capabilities to allow for analysis of data as needed.

It is imperative, in this age of technology, that reports are easily accessible and available in multiple formats such as MS Word, Excel, and PDF and can easily integrate digital images and GIS maps into the reports. The MTC demonstrates this type of flexibility in their StreetSaver program which allows for integration of GIS maps from various external sources through on-line portals. Smaller agencies can use this data to present information on maps to their local city councils in order to request funding for critical projects.

While many of the agencies interviewed recognized the importance of having easy mechanisms for executives to run reports on-demand, some private sector companies simply compile books of operational performance metrics and distribute these within their organizations for critique and self-improvement.

If agencies and companies do not already have systems similar to COGNOS for displaying performance data in a dashboard format, many are actively seeking ways to develop such systems. One example of this is from the Maryland Transportation Authority (MDTA), which is working to develop an on-line on-demand access for executives to run reports similar to their Finance at a Glance report, which already is in use by MDTA staff.

Using a public report card, as demonstrated by the KSDE, also is a powerful motivator for schools to continue striving for excellence in education in Kansas. This allows for a comparison among school districts and assessments of performance relative to national standards. Similarly, the "Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance Report to Congress" issued by the Federal Highway Administration gives a state-by-state comparison of the condition of public roads in each state. States can then assess how well their roadway system compares with other states of similar size and population.

Depending upon the size of the organization it is possible to purchase off-the-shelf software to handle the tracking and management of data, as is the case in the city of Coral Springs, Florida. The city uses a web-based system known as Active Strategy to handle the functions for managing their performance data.

Just as implementing data governance does not follow a one-size-fits-all approach, each agency should determine their needs for managing their data systems and their documentation and reporting requirements, and invest in systems that best suit their business needs.

4.6 Technology

The role of information technology in an organization, such as a DOT, is generally a centralized function, with technical support provided by a distributed network of IT professionals throughout the organization. Sometimes, additional technical support is provided through the use of external outsourced services from the vendor community. If it becomes necessary to outsource IT support, strengthening the internal flow of data and communication of information is even more critical. This is where the use of Business Intelligence (BI) tools is most effective. Several of the available tools are discussed in this section.

A part of the institutional arrangement for supporting data management, governance and stewardship also includes establishing policies and standards for collection and use of data within the organization. This is usually a function of the IT office, as well. There are benefits as well as disadvantages or challenges that can occur based on centralizing this responsibility with the IT office. Some of the issues are related to the organization and access of data and may include the following:

- **Flow of data**—The flow of data and information needs to be coordinated but not controlled in such a manner that it limits or impedes access to the data by those needing it to support daily business operations.
- **Ability for different divisions and individuals to query data**—Query capabilities for data applications and systems should be allowed from different divisions and individuals in order to enhance their ability to support core business functions across the agency.
- **Flexibility**—There also needs to be as much flexibility as possible designed into the application so that there is potential for future integration of new technology for data collection, processing, and access and reporting from the system.
- **Stovepiping**—The historical approach to developing applications in silos where an application only meets the needs of a particular area of the organization has led to "stovepiping." This inhibits the integration of data from various

applications and limits the ability to provide consistent, high-quality data from a single source to support decision-making.

- **Security**—Determining what level of security to assign to data systems should be done in consultation with the IT office and the business owners and stewards for the data systems. It is the responsibility of both users and providers of data to ensure that the data systems are protected from unauthorized use or misuse by others internal or external to the organization.
- **Efficiency**—Utilizing the best available technology tools helps to ensure efficiency in the collection, processing, and reporting of data for various systems.
- **Response to individual user needs**—Ultimately the data programs and systems need to be available to respond to individual user needs, whether the user is the front-line employee responding to requests from the public or internal and external offices or agencies, or the user is a senior-level executive needing the most accurate information within a short timeframe.

There are many BI tools available which can help benefit the organization in addressing these challenges. Some of these tools and their benefits are described in the following section.

Business Use Case Models

Business Use Case models are not only used to help identify what data are shared within an organization and external to an organization, but also to identify who is involved in the sharing of data. RCG Information Technology Company found that many times business executives were not aware of the relationship of which data systems were used to support key business functions. Developing data business models helps to identify this for executives who also have authority over funding for those data programs.

The use of data modeling tools helps the agency to develop enterprise data systems, which best meet the business needs of the organization. These tools are used to develop the data architecture for application systems. The Data Architecture describes the activities required to obtain and maintain data that supports the information needed by the Corporation's major business areas. Data and information are different. Data is the foundation of information. Data is the raw material that is processed and refined to generate information. Information consists of a collection of related data that has been processed into a form that is meaningful to the recipient.[8]

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[8]Implementation of E-Government Principles, AUDIT REPORT, Report No. 05-018, May 2005.

Knowledge Management Systems

KM systems are used to support the internal sharing of data and information within the organization. Knowledge management systems are beneficial because they generally accommodate a wide variety of formats for storing data and information. Reports as well as digital images can be archived and retrieved through the search and retrieval functions of the KM system. A KM system also can be used to store lessons learned which is very valuable in reducing the learning curve for new staff.

Some organizations, such as the Virginia DOT have even established an office to oversee knowledge management processes within their agency. VDOT is joined by Alaska, which is now investigating the use of knowledge management at the Program Development Division as part of their Data Business Plan development for the Division. The U.S. Army also is very actively engaged in the use of a KM system at the U.S. ARDEC as discussed in Section 4.4 of this report.

Archive Management Systems

One of the biggest challenges faced at many of DOTs is managing archived data. Some agencies have invested in the development of archive management systems and others have outsourced the archiving function to other agencies or the private sector. This is the case with the OOCEA, where most of the data maintenance work that is outsourced is predominantly devoted to managing the archive data. The decision on how to approach archiving of data should be properly scoped to meet the needs of the organization and should take into consideration the amount of data to be archived, for what period, and the costs associated with archiving data.

Risk Management

Risk management has traditionally been used with Asset Management systems and is becoming more prominent in the use with data systems in DOTs as well. The benefits of establishing a risk management program include early detection of potential problems, which provides enough time to develop a strategy to avoid risk. The following are the five basic steps in developing a risk management plan:

1. Identify the risks;
2. Assess/Analyze the risks;
3. Develop a plan to mitigate (avoid) the risks;
4. Assign resources to handle the risks; and
5. Monitor ongoing and potential risks.

There also are tools available to help an agency develop a risk management plan. Some of the tools are briefly described in the following paragraphs.

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Table 4.1. ADOT&PF risk register example.

Identification									Qualitative Analysis	
Priority	Status	ID#	Date Risk Identified	Functional Assignment	Threat	Risk Details	Risk Trigger	Type	Probability	Impact
1	Active	TDS-001H	5/01/2008	TDS-HPMS	Need to revise HPMS report to comply with 2010 requirements.	All internal data files and programs will need to be reviewed and revised as needed to provide HPMS 2010 report.	FHWA mandate for new HPMS 2010 requirements.	Schedule Available Resources Cost	H	H
2	Pending	TDS-001T	1/01/2009	TDS-Traffic	Need to comply with Section 1201 – SAFETEA-LU requirements.	Need Real-Time Traffic Mgmt. Plan within 2 yrs. of final rule on Sect. 1201.	SAFETEA-LU requirements.	Schedule Available Resources Cost	H	H
3	Pending	TDS-001G	9/01/2008	TDS-GIS	Need to meet HPMS 2010 GIS requirements.	Will need to provide HPMS 2010 report in GIS format.	FHWA mandate for new HPMS 2010 requirements.	Schedule Available Resources Cost	H	H

A Risk Register can be used to record information about the risk. This includes a risk identification number assigned to the risk, the threat that may precipitate the risk, the event that will trigger the risk, and the qualitative analysis to be performed related to the risk. This analysis can include the probability of the risk occurring (low, medium, high); the impact to the organization if the risk occurs (low, medium, high); and the development of a risk matrix which measures the probability of the risk occurring versus the impact if the risk occurs.

Table 4.1 provides an example of what a Risk Register might look like, regarding HPMS 2010 and Real-Time Traffic Reporting (SAFETEA-LU, Section 1201) requirements, which will impact all DOTs within the near future. This example was developed for the Alaska Department of Transportation and Public Facilities Program Development Division to support their Data Business Plan Development.

In addition to the Risk Register, a Risk Impact matrix (Figure 4.4) also can be defined for the data systems.[9] A Risk Impact Matrix is a tool which defines a two-dimensional risk universe. In this example, the risk universe describes potential risks associated with asset management where the asset is bridges. Risk management programs for asset management also are very applicable to data programs, since data are a type of asset.

The two dimensions in the risk universe are the (1) probability of service interruption or, in the case of data systems, the probability of lack of access to the system during a 12-month period for instance from the time the risk is identified, and

(2) consequence of service interruption or impact to the Division or Department due to the interruption of access to needed data over the same 12-month period.

This matrix was produced using the Lloyd's Register's Arivu platform. In the Arivu matrix both the probability and consequence dimensions specifically use an order of magnitude difference moving from one cell to the next.

Geographic Information Systems

The advantages of using GIS tools for data integration cannot be overemphasized. Many DOTs have GIS maps for their on-state system but do not have data available at the DOT for the local road networks. GIS tools can be used to integrate the needed off-state system roads from local sources, which facilitate the agency's ability to meet Federal reporting requirements particularly in the safety area. Agencies also may require systems to be designed with Service Oriented Architecture and Open Database Connectivity, which provides for a much more flexible system to integrate with future systems with minimal effort. There also are tools available to assist DOTs in the development of risk management plans.

Enterprise Database Platforms

Twenty years ago, most companies operated a variety of legacy systems that contained various databases that did not relate to one other. For example, customer service had a database of customers and orders, logistics had a database of shipments, production had a database of lots produced, and engineering had a database of specifications. Today, most companies have migrated to an ERP platform, where most of this

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[9]Transportation Risk Management presentation, Steve Pickrell, Cambridge Systematics, Inc., July, 2009.

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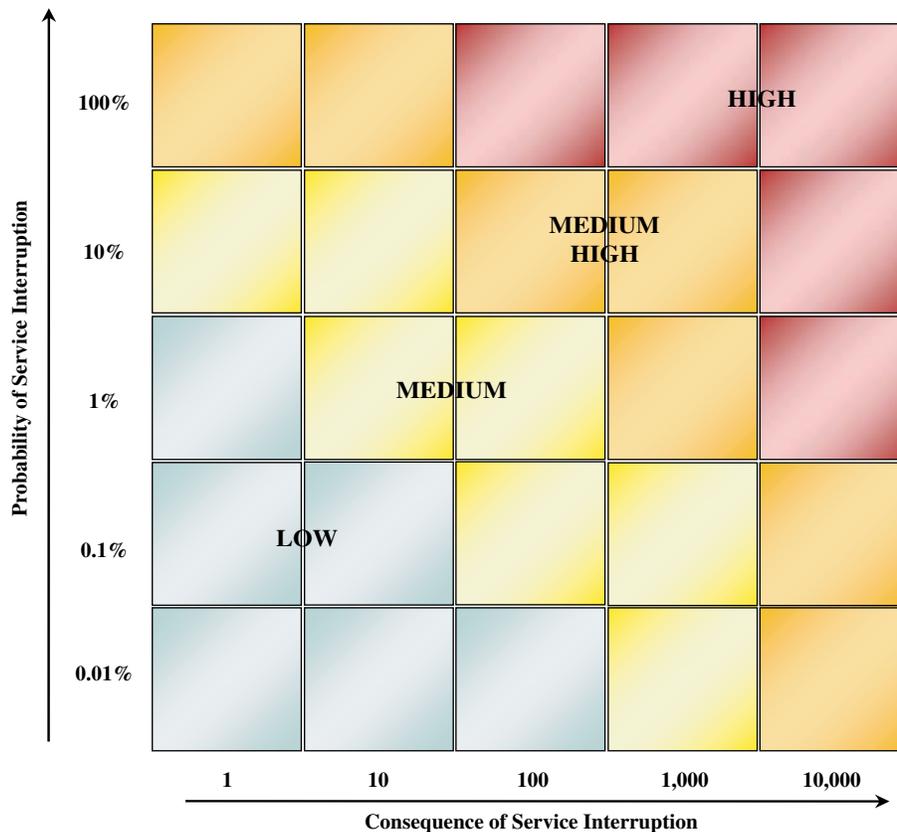
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Figure 4.4. Example risk matrix.

data are stored in a way that it can be accessed from anywhere and related to other data in the central repository. For example, if a quality problem is detected, companies can identify which orders, production lots, shipments, and customers are affected from one database, and possibly with one query.

Today, the same companies typically operate a distributed network around a central (or enterprise) database. ERP systems and the utilities and middleware that are associated with them include LAN workstations, servers, data centers, mainframes, and direct access storage devices. The corresponding advancements in the use of hardware may include a variety of peripheral devices that enable communication and execution in field operations, such as wireless devices, including PDAs, printers and scanners, and communications devices such as microphones and headsets.

Based on these preliminary case studies, private sector companies are increasingly using technology to support their resource allocation and their target-setting in the following ways:

- Software is used to generate optimal solutions in the planning phase. Software applications (usually customized) contain embedded decision rules about capacity, expenditure, and priority. For example, customer relationship management (CRM) applications determine the priority of a

customer order based on the customer's importance to the company; the capacity management system determines the shift schedule depending on the workload; and the purchasing system regulates expenses based on authorization thresholds specific to certain organizational levels and even specific individuals.
- Enterprise applications are used in the execution of shipments and dispatching of fleet and equipment.
- Electronic funds transfer is used in the clearing of funds flows.

The supply chain has practically become the information chain, with incorporation of information technology in various stages of the chain. Table 4.2 illustrates the sequential order of the use of technology in the private sector from the planning through execution stages.

Global Positioning System

There are many similar opportunities for the use of technology at a state DOT to reduce the costs associated with collecting and distributing data. The implementation of hardware and software in specific cases may help to improve data quality by reducing duplicate data collection and QA/QC procedures, as is illustrated in the case of WSDOT. WSDOT was able to reduce

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Table 4.2. Common applications of information technology to private sector transportation performance management and measurement.

Area	Technology
1. Supply Chain Planning	Inspection
	Network design and site location
	Network optimization
	Specification of order types, terms, and conditions
	Trading partner collaboration
2. Transportation Planning	Mode selection
	Routing and scheduling
	Transportation Management Systems (TMS) implementation
3. Procurement	Auctions
	Contract negotiation
	e-Auctions
	Purchasing Cards
	Request for Quotation (RFx)
	Supplier management
	Supplier selection
4. Manufacturing	Advanced Planning and Scheduling (APS)
	Manufacturing Execution
	Materials management
	Production scheduling
	Quality management
5. Order Fulfillment	Customer Relationship Management
	Demand forecasting
	Enterprise Resource Planning Systems (ERP) implementation
6. Inbound and Outbound Transportation	Dispatching
	Radio Frequency Identification (RFID)
	Track and Trace, e.g., Global Positioning Systems (GPS)
	Traffic management
7. Warehousing	Inventory management
	Packaging
	Packing
	Picking
	Receiving, Put-Away, Loading
	Warehouse Management Systems (WMS) implementation
8. Maintenance	Equipment repair and maintenance
	Facilities maintenance
9. Funds Flows	Auditing
	Billing
	Claims processing
	Collections

Source: Boston Strategies International, Inc.

the cost of roadway data collection by using GPS technology to enhance back data collection activities on routine maintenance activities. The data also was edited at the point of collection, eliminating extensive postprocessing time and costs. This was an efficient way to gather the data needed to update the GIS basemap, which, in turn, is used for many projects and purposes throughout the agency.

Many public and private sector agencies also have invested in the use of various types of BI tools to meet their data collection, analysis, reporting and archiving needs. "BI tools are a type of application software designed to report, analyze, and present data. The tools generally read data that have been previously stored, often, though not necessarily, in a data warehouse or data mart."

The effectiveness of the use of BI tools is best illustrated in the description of ARDEC's use of business intelligence tools: "These systems provide the power we need to capture, manage, and make available workforce knowledge, best practices, processes and procedures, templates and other information to the entire workforce."

Dashboards and Scorecards

One of the more commonly used BI tools is COGNOS, which is used as a dashboard for display of information about performance measures related to core programs in an agency. COGNOS is the official management reporting tool designated for use at ADOT&PF, and is widely used in departments throughout Hennepin County.

Hennepin County uses a combination of MS SQL server as its database platform and the COGNOS@ Metric Studio tool for managing its Balanced Scorecard Information for each department in the county. Each department has its own scorecard for performance measures related to their programs, and managers in each department can easily monitor these on a routine basis. Issues regarding performance can be addressed as appropriate with individual departments and measures can be adjusted when necessary to ensure that all programs are functioning in the best interest of the public.

Future Technology

In addition to current tools that are available, there are evolving trends in the use of IT technology tools that will become more widespread in the future, such as the use of Extensible Markup Language (XML). XML offers different functionality than Hyper Text Markup Language (HTML). XML basically is used for storing and transmitting data, while HTML is used for displaying data. There are many benefits offered by using XML, but one of the main benefits is that it does not depend on specific types of hardware or software for its use. With the global ability to use mobile phone service for accessing data and information, this functionality now offers another opportunity for organizations to consider another method for timely transmission of data. In the case of a DOT, use of this technology is very beneficial for real-time traffic management systems.

Each of the examples from WSDOT, OOCEA, Hennepin County, RCG Information Technology, ARDEC, ADOT&PF, Mn/DOT, and future technology trends illustrate how critical the use of technology is in providing the foundation for standardized, quality data systems, which are sustainable over time, to meet the core business needs of the organization.

The use of technology and formal institutional arrangements to support data management provide a strong platform for meeting the business needs of the organization in a timely manner.

4.7 Relationships to Target-Setting and Resource Allocation

This research indicates that the approaches used for target-setting and resource allocation are somewhat different in the public and private sector.

In the private sector, once a target is set, companies do not universally agree on whether or how to link achievement of the target with allocation of resources. The following four approaches are used in practice:

- Allocate resources based on historical levels;
- Allocate resources based on achievement of the target;
- Allocate resources on the basis of relative financial performance, such as return on investment for capital expenditures, and cost/benefit for operating expenditures; and
- Use a hybrid approach.

The easiest approach is to allocate resources based on historical levels, often including an increment or a decrement for inflation and economic growth. However, this is generally viewed as the least effective way to allocate resources since it can result in years of inertia and resistance to change and can perpetuate wrong resource allocations year after year. Many public organizations and departments allocate resources this way, but private sector companies largely switched from this approach to a zero-based budgeting approach.

A second approach to allocating resources is to base the resource allocation on achievement of the target. Those that hit or exceed the targets get more resources. The logic is that the target is a point on a continuum, and the more you exceed the target, the more value you add. Most private sector companies' personnel bonus compensation plans work this way. Exceeding the target is usually viewed as a performance worthy of reward. Those that hit or exceed the targets get fewer resources. The logic is that going beyond the target yields little incremental value and that once a target has been attained resources should be diverted to the next highest-yielding endeavor.

A third approach is to allocate resources based on relative financial performance, such as return on investment for capital expenditures, and cost/benefit for operating expenditures. This method raises technical issues such as how to ensure consistent cost/benefit calculations and when to consider expenditures as capital investments versus operating expense—for example, should repaving a roadway be considered a capital expense or an operating expense?

A hybrid approach is often the most practical one to take. For example, a hybrid approach might use all four approaches under different circumstances as follows:

- Allocate capital expenditures on the basis of ROI;
- Allocate operating expenditures on the basis of cost/benefit ratio;
- Allocate initial annual resources based, but offer bonuses based on achievement of a target at the end of a year; and
- Establish control levels so achievement beyond a certain level is not rewarded, in order to protect against lower optimization of resources, especially in capital-intensive operations.

The public sector, likewise, may allocate resources based on historical trends, or on the ability of a particular program to meet agency goals consistently. Programs in the public sector that demonstrate consistent success, however, are not likely to receive monetary bonuses for employees, per se, but they are able to receive continued funding from those who make the decisions on how funds are allocated.

Many of the companies and agencies interviewed also recognized the importance of integrating targets and measures into the job functions listed in each employee's performance plan, in order to motivate the employees to work harder to achieve or exceed targets. The employees gain a better understanding of the significance and relevance of meeting or exceeding targets, when the targets become part of that employee's job duties.

The KSDE has a Data Quality Certification Program that offers professional development training to its employees. The program recognizes the contribution of individuals who enter statistical data into databases for the school districts by presenting framed certificates to them upon completion of the program and recognizing them on the agency website. The motto for the program, "the data pays you and grades you," is a great motivator for employees to strive to provide the best quality data to the school districts.

Another example from the public sector of how target-setting affects resource allocation is from WSDOT. WSDOT was able to gain legislative funding support for continuing the Fish Barrier Removal Program by demonstrating to them the increase in migratory fish population to be gained by removal of the barriers. This fish population is important to the gaming and fishing industry in Washington. When the measures and targets were presented to the legislature, continued funding of the program was approved above others that also were competing for similar funding.

ARDEC collects performance data on finance-related indicators, labor hours, revenues, purchases, human resource information, and others. Its goal is to use this data to eventually manage the status and availability of staff at the work breakdown structure level. Even though ARDEC's priorities are established by others, the organization uses its available data to manage resources.

The OOCEA is challenged with managing travel on the expressways in the Orlando/Orange County area. Based on the data collected on travel times and reported in the monthly Expressway Travel Time Performance report, the toll authority is able to determine when and where to add staff at toll stations during peak travel times. Travel time performance indicators at OOCEA directly influence resource allocation. One of the strongest examples of performance-based management comes from Hennepin County. There is strong support for performance management at the county administrative level and the strategic plan for the county includes goals established for each functional area in the county. The managers in

each area are responsible for monitoring the goals, targets, and success rates for their departments and use the balanced scorecard method to monitor progress. Depending upon the program, the indicators may show that additional resources or funding is needed in a particular area and the need is justified, based upon the performance indicators.

The City of Coral Springs, Florida, also has a very well-defined set of key intended outcomes (KIO) which are performance measures covering seven strategic priority areas. There also are specific sets of data collected to support the seven areas. Through monitoring the data reflected in the performance measures and targets, the city can make improvements in resources as needed, such as adding more fire trucks or personnel to respond to calls within a certain amount of time. The City holds itself directly accountable to the citizens of Coral Springs and the performance measures data plays an important role in ensuring that the needs of the citizens are met by the City staff.

There also are areas where performance measures data may be lacking and this has a negative impact on the agency's ability to allocate resources for that program. Without the data to indicate how a program is performing, it is difficult to get the necessary approval for funding and resources.

Hennepin County has indicated that while specific department areas may have excellent performance measures data that can be used to allocate resources, there is a need to have more data available on a countywide basis. Likewise, the MTC has recognized the need to improve the connection between the use of performance measures and those who collect data for the various programs and make funding decisions on data programs. They want to have access to better data for monitoring carbon dioxide emissions to comply with the Clean Air Act. They also need better crash data in order to establish performance measures to improve safety and reduce collisions in the Bay Area.

Whether all needed data are available to support performance measures and resource allocation most organizations recognize the advantages of investing in data systems which provide good quality data to assess how their core business programs are performing. In the private sector, having high-quality data may not be a priority compared with other business goals. Private companies tend to place more emphasis on root cause analysis of problems in a particular area than on data accuracy. This does not suggest that bad quality data are acceptable, but that the incremental cost of getting good quality data may not be worth the additional interpretive value. Many public sector agencies however have been successful in providing timely information based on quality data to the legislature or other state and local agencies, as well as the tax payers who have a say in whether funding for a particular program will continue or not.

Each of the examples provided in this report illustrate how the methods for defining targets and performance measures

is strengthened through the use of well-organized and well-managed data programs. These programs are, likewise, streamlined and strengthened through the use of Business Intelligence tools which support the collection, processing, and use of the most reliable and accurate data and information, on behalf of the organization.

These data management functions operate most effectively within some type of data governance framework and with the appropriate BI tools. The continued availability of quality data is essential for allocating resources effectively, and for improving the speed at which improvements in business areas can be made.

4.8 Summary of Success Factors and Obstacles

Success Factors

Several success factors related to effective data management systems and institutional relationships to support PBRA were common to many of the case studies: use of data business plans, identification of a data champion, good coordination between IT and business functions, data governance applied from the top down and clearly defined, achievable goals. Descriptions of the success factors revealed from the case studies are provided in the following sections.

Establishing the Need for Data Management/Governance

- Demonstrate the ROI to the organization regarding the use of data management and data governance in order to gain buy-in from executives and decision-makers. Demonstrate with specific examples how the use of data governance can meet the goals and targets most important to executives.
- Formalize a Business Plan for the agency or department which identifies how each employee's job is linked to the agency's mission and goals, thereby, clarifying the importance of their role in the overall success of the department/office.

Assessing Current State of Data Management in Agency

- Perform a health assessment of data systems to determine where the most critical deficiencies exist and to develop a strategy for addressing those deficiencies.
- Perform a risk assessment of existing data programs to highlight the importance of mission critical programs to management and, thereby, gain continued support for those programs.

Planning for Data Management

- Start with a smaller achievable goal, when implementing data governance within an organization, and build on small successes to address larger agency goals.
- Use a Data Business Plan to strategically manage data programs similar to other strategically managed programs within the organization.
- Manage expectations of how data governance can help an organization by explaining the benefits of such models for supporting business operations.
- Use Business Models to help executives and managers better understand the relationship between target-setting and decision-making.
- Identify champions from Business and IT sides of an organization to support key systems. Partnerships between both areas are critical to successfully managing data programs.

Executing a Data Management Plan

- Implement a Data Governance Board or Council to address issues related to development, implementation, and use of data programs which are critical to supporting business functions.
- Clearly identify the roles/responsibilities of the staff responsible for supporting critical data systems using a Data Governance Manual or other means.
- Collect the right data and the right amount of data, or to put it another way, don't be data rich but information poor. Present information to decision-makers in a clear and understandable way.
- Use BI tools (web-based applications, GIS, dashboards, etc.) to allow easy access to data systems and sharing of information among employees and decision-makers.
- Communicate with stakeholders to sustain support for various programs. Continue to provide outreach to all communities of interest to ensure that all needs are addressed.
- Develop a business terminology dictionary to align the use of business terms commonly used throughout an organization. This is particularly helpful to staff such as IT professionals who are often responsible for developing applications to meet business needs.
- Design data systems so that they can be modified in the future without requiring a complete redevelopment of the software.
- Create an annual data file for each data program so that consistent information is provided throughout the year.
- Communicate the need for and share metadata with managers and policy-makers throughout the organization. Metadata is critical when needing to compare data side-by-side from different data systems.
- Establish, update, and enforce polices and procedures to govern data management.

Maintaining Data Management

- Use Service-Oriented Architecture (SOA) and Open Database Connectivity (ODBC) in the design of new application systems to enable sharing of data and information across systems.
- Manage data as an asset in the organization, through policies governing the collection, maintenance, and use of data.
- Use data standards to:
  – Facilitate establishing targets and measures which meet agency goals.
  – Reduce the cost of multiple data collection efforts and maintenance of duplicate databases. Strive to collect data once, use it many times.
  – Facilitate consistent reporting of information.
- Use data sharing agreements to reduce costs associated with data collection and maintenance of data systems.
- Invest in the staff by providing training in new technology and tools to gain their buy-in for support of data programs and data governance initiatives. Provide professional development opportunities for staff.
- Invest in new technology training for staff. The ease of access to data and the computer savvy ability of staff to utilize technology in creating their own queries and reports has enabled them to more readily attain their goals. The relevance of this particular benefit should not be overlooked at the state DOT level. This investment will ultimately produce beneficial results for the agency.

Linking to Planning, Performance Measures, and Target Processes

- Use a hybrid approach that employs modeling and benchmarking to establish agency targets and performance measures.
- Don't use a one-size-fits-all approach in establishing performance measures and targets. Use the correct metrics for making decisions. Focus on continuous improvement by revising/adding new metrics as needed.
- Link the performance measures and targets for a program to budget allocations, improving participation by staff in supporting the performance measures and targets. The performance measure and target-setting process also can be used to motivate employees by linking their performance plans to objectives identified in specific performance measures and targets.
- Allow DOT transportation planning staff routine access to other planning offices (regional, district, etc.) and technical resources available in the agency. This strongly enhances a performance-based management process.
- Reward business areas which consistently meet targets and goals. Consistent achievement in meeting targets is a powerful motivator for behavior: success breeds success.

- Use external data sources, such as environmental, historic, and other planning agencies for GIS data layers to improve the data used for the performance measurement process when funds are limited to collect this data using internal resources.
- Utilize software that is procured or developed internally to automate as much of the performance measurement process as possible. This will allow for more time devoted to the analysis of the performance results.
- Revise or stop using targets if performance data are not easily obtainable when a performance target is used.
- Programs which do not have a direct link between that program or project and performance should not be funded.
- Identify business units responsible for maintaining current metadata about each performance measure. This facilitates the analysis required for user requested data and information system changes and enhancements.
- Include objectives pertaining to resource allocation in the agency Business Plan. The current Business Plan at the MDTA, for example, has three separate objectives related to resource allocation. These include System Preservation, Implementing and Asset Management System, and Integrating MDTA's financial system with other systems.
- Use external data sharing agreements to obtain data for performance measures that the agency does not have. For example, MDTA collaborates with other agencies for several measures that it needs additional data for, or does not have the necessary equipment to monitor itself.
- Establish performance targets through a streamlined process and revisit and revise (as needed) periodically.
- Incorporate customer satisfaction as a measure in setting performance targets.
- Utilize incentives to facilitate meeting performance objectives, including awarding bonuses based upon job performance and using quantitative objectives embedded in professional employees' annual objectives.
- Arrange performance measures in a hierarchical order, allowing an agency to translate strategic goals/objectives into operational goals/objectives for each department. The U.S. DOT follows this approach among its various administrations (e.g., FHWA and FTA), allowing it to provide a performance budget that can be related to actual and planned accomplishments for each department. This same scenario would apply to a state DOT, with several divisions, districts, and/or independent offices. The performance in each area then becomes a key basis of resource allocation and budgeting.

Obstacles/Challenges

Several common obstacles also were identified through many of the case studies. These included the lack of use of BI

tools, and the fact that data programs are not linked. Specific items are described in the following sections.

Establishing the Need for Data Management/Governance

- From a corporate perspective, the investment in IT systems has to be justified by a benefit, and the benefit of better data quality is often not worth the incremental investment. State DOTs similarly, are faced with the challenge of justifying the benefit to the agency in investing in better data quality standards, processes, and policies.

Executing a Data Management Plan

- Lack of data standards causes adverse impacts on data integration efforts.

Maintaining Data Management

- Data quality within the organization may not be good enough to support decisions. Need to improve data quality.
- Non-integrated data systems limit the sharing of information and sound decision-making, based on data programs.
- Data providers need to learn how to "market" their product.

Linking to Planning, Performance Measures and Target Processes

- There is often difficulty in identifying what performance measures are needed and how to establish metrics for those measures.
- External influences and/or political pressures often influence funding for various programs. While the use of performance measures and targets can demonstrate the need for sustaining various data programs, organizations should understand that ultimately, external mandates may reprioritize organizational goals and targets, and subsequently data programs.
- There is a need to address the gap between data supported decisions and data-driven decisions.
- Specific performance measures may not be pursued because a baseline cannot be developed using existing data (i.e., percent reduction in error in all transactions, etc.).
- Not having data centralized is the biggest challenge to target-setting and performance management. Data currently are collected in a variety of formats in a number of different legacy systems. These legacy systems require duplicate entry of data into multiple systems.
- Improvements in data quality and quantity would allow for improved performance-based decision-making and management.

- The biggest challenge may be one of organizational culture change. Managers and directors need to gain more experience in performance-based decision-making and management.
- In the case of the Maryland SHA, the largest data sharing challenge is coordinating with outside agencies that provide performance data for key or legislatively required measures. This is a particular challenge in the area of Safety, where data such as incidents, fatalities, and injuries must be collected from police reports. This information frequently must be derived from hand-written and/or paper records, and is very time consuming.
- In a private sector company example, there was a group within the organization that was responsible for data quality, but the group was disbanded because it was perceived that they did not add value to the organization. This makes it even more challenging when the company acquires other companies and has to merge data across databases.
- Having better, readily available data would make a tremendous difference in the ability to measure progress in meeting performance targets.
- The biggest gap in data is with trading partners that use different information systems. ABC Logistics relies on solid relationships with its partners to ensure continued attention to improving data quality. State DOTs similarly are faced with the challenge of merging data from separate, silo systems, perhaps from different offices, or divisions within the DOT. Developing a partnership with those offices facilitates the development of processes to integrate the needed data and information into one system.

4.9 Future Research

Transportation agencies continuously find themselves faced with challenges from many constantly changing variables outside their control: inflation, political priorities, and revenues, for example. It is within this environment that transportation agencies must establish a data based planning, programming, and budgeting decision framework. Agencies need to develop short term project budgets and long term financial plans for TIPS, STIPS and LRTPs. Available resources, including money and data, affect the establishment and attainment of performance targets.

Risk Assessment

As a result of the uncertainties facing transportation agencies, there is an opportunity to apply risk assessment and management to PBRA. However, few examples of comprehensive risk management exist beyond limited application in system preservation and asset management areas such as pavement

and bridge maintenance. For example, *NCHRP Report 632: An Asset-Management Framework to the Interstate Highway System* recently provided guidance on risk assessment in the context of managing the Interstate highway system; the 8th National Conference on Transportation Asset Management also provides examples.[10,11] There is a need for further research on the role of risk management within the overall performance management framework. Development of an annotated list of specific methods in use, their strengths and weaknesses, and potential applications to PBRA would be a useful next step.

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[10]Cambridge Systematics et al., *NCHRP Report 632: An Asset-Management Framework for the Interstate Highway System.* Transportation Research Board of the National Academies. Washington, DC. 2009.

[11]Eighth National Conference on Transportation Asset Management (http://pressamp.trb.org/conferences/programs/program.asp?event=486).

Information Technology Tools

Data management systems within transportation agencies must incorporate data sharing ability and techniques to effectively support target-setting and PBRA. This report and subsequent guidance includes data sharing topics such as technology for sharing and integrating data. It also discusses how evolving trends such as data exchange formats are affecting data sharing. However, there is a need to expand on this research/guidance to cover issues such as the role information technology plays in supporting data management particularly related to target-setting and PBRA. Specific topics include expanding the knowledge base on the use of business intelligence tools which are applicable in the transportation environment; the role of data security/access in supporting or hindering data sharing; and data privacy issues and its impact on data sharing. A primer related to the impact of these data sharing information technology topics on the success of data management for PBRA should be prepared.

Guide for Target-Setting and Data Management

CONTENTS

Guide for Target-Setting

This Guide for Target-Setting outlines a structure that can be used by transportation agencies for developing and evaluating targets. This section describes the actual structure and how an agency might implement it, including examples gleaned through actual agency implementation (these examples reference Case Studies provided in Volume III, which has been published as *NCHRP Web-Only Document 154*).

Target setting must be applied strategically and carefully, with an understanding of the context in which targets will be applied. There is no one predefined, prescribed approach for setting and using targets because their intended use can vary greatly; in fact, no agency currently relies on a single, prescribed, systematic approach for setting targets. Using the information from the case studies, as summarized in Volume I, the seven-step process from *NCHRP Report 551* can be reconstituted and refined within the context of the PBRA framework to create a flexible structure to guide agencies in setting targets. The structure is as follows:

- **Step 1—Establish Performance Management Framework.** Establish the Framework that links organizational goals to resources and results. Performance measures and their attendant targets are the link connecting goals to specific investments.
- **Step 2—Evaluate the Factors Influencing Target-Setting.** Ask the right questions about the factors internal and external to the agency that affect target-setting and the approaches that can be used.
- **Step 3—Select the Appropriate Approaches for Target-Setting.** Based on the factors in Step 2, select an approach or approaches for setting targets.
- **Step 4—Establish Methods for Achieving Targets.** Within the context of the Performance Management Framework, identify methods that orient the agency and its resources towards achieving the targets set in Step 3.
- **Step 5—Track Progress Towards Targets.** As part of the "Measure and Report Results" element of the Performance Management Framework, track progress specifically against targets.
- **Step 6—Adjust Targets Over Time.** Based on financial and political realities, ease, or difficulty of achieving targets, and increasing experience in PBRA, use the feedback loop in the Performance Management Framework to reevaluate and adjust targets.

Table 1.1 provides a comparison between the seven-step process used in *NCHRP Report 551* and the approach suggested in this report.

The following sections explain each of the suggested six target-setting steps in further detail.

Step 1—Establish Performance Management Framework

Performance-based resource allocation (PBRA) takes place within an overall Performance Management Framework. The six elements of the Performance Management Framework are described in Figure 1.1; the Framework is described in greater detail in Volume I, Chapter 2. To

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II-6   Guide for Target-Setting and Data Management

Table 1.1.   NCHRP Project 8-70 target-setting structure compared to *NCHRP Report 551* seven-step process and performance management framework.

| NCHRP Project 8-70 Approach	*NCHRP Report 551* Seven-Step Process	Performance Management Framework
Establish PBRA framework.	• Define the context for target setting and establish time horizon(s). • Develop long-term goals based on consideration of technical and economic factors.	Entire framework, within agency context.
Evaluate the factors influencing target-setting.	• Determine which measures should have targets. • Consider current and future funding availability. • Consider policy and public input implications for target setting.	Target setting.
Select the appropriate approaches for target-setting.	• Establish targets.	Target setting.
Establish methods for achieving targets.	• Analyze resource allocation scenarios and tradeoffs.	Target Setting and subcomponent of allocate Resources.
Track progress towards targets.	• Track progress.	Subcomponent of measure and report results.
Adjust Targets Over Time.	N/A	Part of feedback loop.
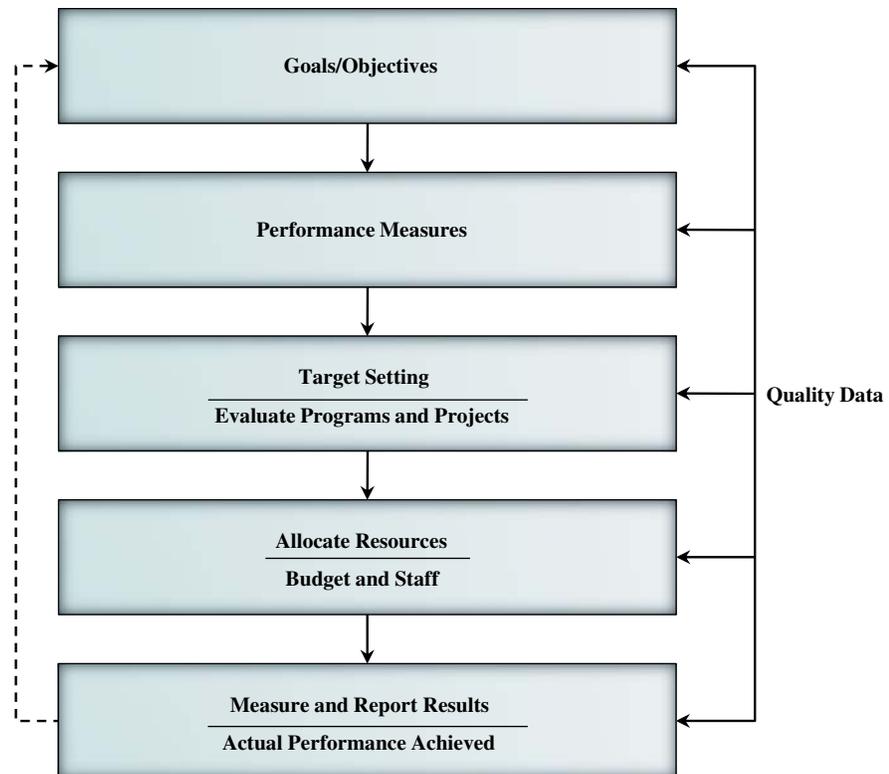
Figure 1.1.   Performance management framework.

summarize, Performance Management is a business process that links organizational goals and objectives to resources and results. Performance measures and their attendant targets are the lynchpin in this process connecting goals to specific investments. The approaches by which measures and targets are set and the methods by which they are used in investment decision-making play critical roles in the overall success of a public agency or private company.

Establish Goals and Objectives

Performance–based resource allocation decisions are anchored in a set of policy goals and objectives which identify an organization's desired direction and reflect the environment within which its business is conducted. For example, many state DOTs have well-defined goals for the transportation system, including infrastructure condition, level of service and safety, as well as goals reflecting economic, environmental, and community values. Likewise, the private sector frequently establishes policy goals to guide production of products and services while defining the environmental and community context for its investment decisions. Through this first step, many of the factors that will affect target-setting will begin to become more evident (see Step 2).

> In the private sector, the processes used by most companies operate such that every goal should have a target and every target should align with a goal. Most companies prefer to reduce the number of goals and targets rather than risk misalignment or confusion between goals and targets. MNC and Corporation X, both large companies, are focused on cost reduction.

Select Performance Measures

Performance measures are a set of metrics used by organizations to monitor progress towards achieving a goal or objective. The criteria for selecting measures often include the following:

- Feasibility,
- Policy sensitivity,
- Ease of understanding, and
- Usefulness in actual decision-making.

> Companies that use Total Quality Management (TQM) rely heavily on **simple metrics** because changes are implemented at the shop floor level where data must be readily obtained and recorded in order to be credible and immediately actionable. Also, changes in the definition of metrics over time can stifle motivation to achieve the target; companies that use balanced scorecards need *stable metrics* more than most because unstable metrics make the scorecard appear unreliable. DIY Company has consistently used one key metric—transportation cost as a percent of gross trade sales.

Identify Targets

Targets are a quantifiable point in time at which an organization achieves all or a portion of its goals. These points set a performance level for each organizational measure, such as achieving

a 25 percent reduction in highway fatalities by 2030. The steps used to set such a target include the following:

- Establish Performance Management Framework,
- Evaluate the Factors Influencing Target-Setting,
- Select the Appropriate Approaches for Target-Setting,
- Establish Methods for Achieving Targets,
- Track Progress Towards Targets, and
- Adjust Targets Over Time.

> Realistic targets are essential to making rewards and penalties effective in the private sector. The anticipated gains can be embedded in business unit or departmental budgets, and individuals can be more readily held accountable for their performance towards reaching the target. MNC uses an annual cost reduction target that is widely communicated throughout the organization.

Allocate Resources

The allocation of resources (time and money) is guided by the integration of the preceding steps into an organization's planning, programming, and project development process. To the extent possible, each investment category is linked to a goal/objective, a set of performance measures, and a target. Specific investment proposals are defined in relation to specific targets.

Measure and Report Results

The data for each performance measure must be regularly collected and periodically analyzed. The analysis should indicate how close the organization is to achieving its targets and identify the actions necessary to improve results. Many public and private sector organizations have tracking systems in place to monitor performance allowing senior staff to make periodic budget adjustments.

> Mn/DOT prepares a one-page "snapshot" with performance measures and red, yellow, and green colored shapes to represent annual progress relative to targets, by state and by district. The snapshot graphically illustrates the trend direction and projects the next year's forecast. Corporation X uses a combination of hardware and software to gather data from its widely dispersed field operations.

Create Data Management Systems

"Good" data is the foundation of performance management. Effective decision-making in each element of the performance management framework requires that data be collected, cleaned, accessed, analyzed, and displayed. The organizational functions that produce these requirements are called data management systems. The first key dimension centers on the technical challenges associated with data systems, including development and maintenance of hardware and software, and the specifications for data collection, analysis, archiving, and reporting. The second area focuses on the institutional issues associated with data stewardship and data governance. These focus areas will be explored and discussed in Chapter 2.

Step 2—Evaluate the Factors Influencing Target-Setting

Asking the Right Questions

In order to evaluate the factors affecting target-setting for a particular measure in a public agency or private organization, a practitioner can begin by asking a few simple questions. The recommended approach revolves around a process commonly known as the **Five Ws and an H (Who, What, When, Where, Why, and How).**

WHY Is the Target Needed?

"Why" requires thinking about the following factors:

- Internal support;
- Political/Legislative influence;
- Customer service focus;
- Stakeholder expectations;
- Commitment to regular communication and reporting; and
- Types of resources to be allocated.

This involves developing an explicit understanding about why a target is being developed and the particular performance measure with which it is associated. It provides the link between the target and the larger PBRA process (i.e., the specific measure to which it relates and, in turn, the transportation goal/objective that it supports). This requires specifying the measures suitable for a target. Some performance measures may not lend themselves to quantification, while others may support long-term transportation goals but be outside the authority of the agency to influence and therefore inappropriate for defining a prescriptive target. Further, the need for a target related to a specific measure may stem from a need within the agency or from real or perceived needs from elected officials, the public, or other stakeholders.

WHO Will Be Using the Targets?

"Who" requires thinking about the following factors:

- Internal support/culture;
- Political/Legislative influence;
- Customer service focus;
- Span of control/agency jurisdiction; and
- Types of resources to be allocated.

This involves defining who the end-user is for the target; namely, if that user is internal or external to the transportation agency. An internal user, for example, could be a technical staff person using the target to aid in project evaluation, while an external user might be an elected official, Board member, or member of the public who will be using the target to review investment performance. If the end user includes external parties then this factor involves paying close attention to understanding the policy and public implications of setting particular targets (i.e., what is desired versus what is possible given certain resources).

WHERE in the Process Will Targets Be Used?

"Where" requires thinking about the following factors:

- Span of control/agency jurisdiction;
- PBRA history/evolution of state-of-the-practice; and
- Types of resources to be allocated.

This involves defining the point in either the plan development or project delivery process where targets will support the decision-making process (e.g., project evaluation and selection, systems-level review, project design, project delivery, or monitoring of on-the-ground performance). This is closely related to how an agency has implemented the Performance Management Framework, as well as how much experience an agency has applying PBRA.

WHEN Should Targets Be Attained?

"When" requires thinking about the following factors:

- Timeframe;
- Types of resources to be allocated;
- Stakeholder expectations; and
- Commitment to regular communications and reporting.
- Political/Legislative influence

This specifies the time horizon for when the target should be met. A distinction should be made between long-term goals about desired performance levels and short-term targets that represent the best that can be done given known resources.

HOW Will Targets Be Calculated and Achieved?

"How" requires thinking about the following factors:

- Span of control/agency jurisdiction;
- PBRA history/evolution of state-of-the-practice;
- Financial resources;
- Technical resources/planning and forecasting capability;
- Timeframe;
- Political legislative influence;
- Organizational structure; and
- Internal support/culture.

This question can be answered based on two levels of technical rigor. The first, which is less rigorous and perhaps most relevant to the long-range planning aspect of PBRA, is to simply define in broad terms the types of strategies intended to support meeting the target, whether it be by particular project types or investment strategies. The second, which is much more technically rigorous, relies on comprehensive technical analysis that defines how much improvement can be achieved given certain resource allocation tradeoffs and consideration of funding constraints

and various implementation scenarios. The second level of detail, if applied, should feed directly into what the target actually is, as it provides a more detailed perspective on what can actually be attained given certain real-world constraints. However, actual approaches for calculation and achievement of targets depend highly on internal resources and both internal and external influences.

WHAT Is the Target?

This step is the point where a target is actually established, given that the previous questions have been adequately answered. By asking these questions and considering the typical factors affecting target-setting, the practitioner can select the appropriate approach or approaches for setting targets and arrive at targets that suit an agency's needs.

Typical Factors to Consider

There are multiple factors that lend themselves to the development of a PBRA process within transportation agencies. These factors are documented in Volume I and in the Case Studies in Volume III. These are the factors that arise when asking the 5 W's and an H questions in the previous section.

> When reviewing and refining performance targets, it is important to keep in mind that setting targets typically involves balancing a number of factors, which may vary in importance among different measures or products/services. The driving factor is not always the same.

Political/Legislative Influence

Perhaps the most immediate and direct factor influencing target-setting as an element of PBRA is the existence of a commission or other political body to which a transportation agency must report the performance of investment decisions. Political intervention in the process may result from controversy or the increasing public outcry over transportation services that force political attention on an issue.

While political influence of this direct manner can have very complicated repercussions, it has shown to be one of the most positive indicators for implementation of target-setting, if done properly. For almost every agency reviewed that is using targets as part of their PBRA process, political or legislative intervention provided the initial impetus for establishing discrete targets. Political intervention can be triggered by a number of issues, but the most common is the increasing limitation of transportation funding at all levels of government, which has created more competition for available funds and also made it more important to justify funding requests.

The Minnesota Legislature and Department of Finance require that agencies use performance measures in biennial budget documents. Washington State's Legislative Transportation Committee recommended a PBRA process in 1991 that's still in place today.

Political and legislative influence also could result in an "edict from above," obviating the need for an agency to define its own target for a measure (MTC, ARC); sometimes the edict is broad enough that there is still room for more refined target-setting within an agency or division (FDOT).

This can be difficult to negotiate if the process is not properly informed by knowledgeable transportation staff that guide the development of reasonable, attainable targets, considering planning, technical, and funding constraints for an agency (in terms of both ability to achieve and ability to measure progress towards a target). However, if specific targets already have been set externally, it may be necessary to complete the steps of the overall approach outlined in this

guidance—namely, Establish Methods for Achieving Targets, Track Progress Towards Targets, and Adjust Targets Over Time—and through the feedback loop, better inform the target-setting process through the next planning cycle iteration. While political involvement can be challenging, it also can provide transportation staff the support they need to select projects that are proven to improve performance and therefore should be a priority for funding.

> Transportation agencies should guide the development of reasonable, attainable targets by legislatures. However, targets set by external edict may need to be refined through iteration of the target-setting process over time.

Customer Service Focus

Those public agencies and private organizations that have taken a clear customer-service approach to PBRA understand the need to use targets to be able to communicate to the system user, the "customer," the return on their investment. Customer satisfaction is a fundamental aspect of performance for these organizations, and is therefore reflected in the types of measures selected, the measures that are given targets, and how the targets are created. They break down and analyze customer satisfaction or dissatisfaction from broad perspectives that address issues in areas such as social and community impacts and environmental impacts of transportation investments and, in more narrow terms, that address issues related to daily personal travel needs.

In Coral Springs, Florida, customer input drives the decision-making process; target-setting serves as a metric for progress, providing feedback for the community. For ABC Logistics, targets stem from the promises made to its customers in their contracts with the logistics company. A Customer Care program monitors the company's performance relative to the targets and customer expectations, with feedback mechanisms to communicate results to the public and to link individual employee performance (and merit) to performance of the company.

PBRA History/Evolution in State of the Practice

Agencies that are only at the beginning of implementing a performance-based process generally have less complete and less sophisticated target-setting processes. In general, there is a typical evolutionary path that agencies follow. A corollary to this evolution is the emergence of an agency's data sophistication.

Mn/DOT's measures and targets, identified in its 2003 Statewide Long-Range Plan, were refined through application and adjusted in the 2009 plan. MTC's performance-based process also has been evolutionary during the development of its last three long-range plans. WSDOT's experience also confirms that target-setting requires a solid history of performance data as well as managerial comprehension and appreciation of that data, which comes with time and experience. Managers must have the ability to understand transportation system behavior (i.e., "what the data are saying") and to discern what they can or cannot control. Even imperfect measures and targets, if they are well-established, are well understood and have previous reference points (DIY Company).

Commitment to Regular Communication and Reporting

Regular tracking of investment performance and reporting of results to the public and transportation stakeholders serves to focus attention on an issue over time, so that it is not lost in political and public discourse as new challenges arise. Regular reporting and communication of

progress helps to keep staff and the public focused on the particular challenge, especially as is in the private sector when it is tied to agency or even staff-level "merit"/compensation. This helps all involved to understand the nature of solving process problems over the long term, rather than focusing on immediate issues (e.g., fighting fires) that often distract from the larger mission of an agency. It also supports longer-term trend development that is needed to track the performance of investments over time. This commitment to transparency will affect the approach an agency selects to define targets as well as the timeframe of the targets.

Reporting can be both internal and external for public sector organizations, and usually just internal for private sector organizations (with the exception of financial results for shareholders). Many agencies use regular reporting to drive their own internal resource allocation (e.g., finances), as well as to satisfy external requirements (MLIT, OOCEA, WSDOT, MDOT). Reporting mechanisms also interface strongly with managing stakeholder expectations and help to make an agency more customer-service focused. The regular development of reports or other "products" that are distributed to the public and used by decision-makers helps to maintain staff enthusiasm for the performance-based process and ensures the continued development of the necessary inputs for the report (Hennepin County).

Span of Control/Agency Jurisdiction

The span of agency control, whether it is through funding, modal authority, or geographic jurisdiction, plays a strong role in the development of measures and targets, because it controls the perspective from which each investment is evaluated. An agency that manages only highways will have a narrower set of measures than does an agency with jurisdiction for multiple modes. States responsible for all roads, rather than only the higher functional classes, face greater data-gathering complexities. This can influence how they set targets and how they use data to measure progress towards those targets. For instance, Mn/DOT has direct control over the quality of pavement, but it can only influence transit service provided in Greater Minneapolis through funding. In all instances, the level of influence that the department has over a particular measure affects the target that is eventually set. Within DOTs, standard siloing of functions has led to strong asset management systems for roadway maintenance functions, but this process is translating to other DOT functions.

Financial Resources

No constraint or factor in constraining the PBRA process and affecting target-setting is cited as much as financial resources. Financial resources are intimately intertwined with the resource allocation process, both determining an agency's ability to implement such a process by influencing other factors such as technical resources, and also potentially being determined by the process itself. Financial resources also can be used to create "financially constrained" targets that reflect historical or projected funding (MLIT).

Performance data has played a key role in biennial state legislative budget allocations for Mn/DOT, and it also has played an important role in the debate for new transportation funding. Mn/DOT quantified its highway performance measures and targets in its 2003 State Transportation Plan and concluded that Minnesota was underinvesting in its highway program by one billion dollars per year. This performance-based analysis was accepted by the legislature and virtually ended the legislative debate on level of need. The legislative discussion shifted from the question of need to the question of payment. In February 2008, the Minnesota Legislature overrode the governor's veto and passed a funding bill which provided several billion dollars of new funding for transportation over 10 years.

Similar to the influence of financial resources on target-setting, staffing and person-hours of available time can affect the depth of a PBRA program, including targets that an agency can assemble and monitor.

Timeframe

The timeframe of desired results affects how targets will be set and what they will be. Timeframe is sometimes determined by stakeholder and internal agency needs; it also can be dictated by forecasting capabilities.

> Although private sector senior managers and the finance departments usually have long-range goals, most corporate targets are set and performance monitored on an annual basis. To link individual performance to longer-term goals, companies sometimes use equity to incent employees rather than to share multiple annual targets with them.

Many agencies have a variety of different timeframes for different planning and programming purposes, with targets for each of the timeframes. At Japan's MLIT, annual targets are derived in part from the latest major subjects of policy, planning, and programming to emerge from the funding reports from the MLIT and Road Bureau, the Road Bureau's Mid-Term Visioning Report, and the national government's 5-year Major Infrastructure Development Plan. Longer-term targets match this with a 5-year span. This information is used when determining feasible 5-year goals for the Bureau and results in what is essentially a financially constrained target. Maryland uses a similar approach with annual targets, 4-year targets, and 5- to 10-year targets, depending on the particular planning document.

In Washington, the primary responsibility for translating long-term goals (dictated by elected officials) to short-term or "incremental" goals, objectives, and targets falls to the Department of Transportation, in consultation with executive and legislative members and staffs. This process centers on how to set and describe these incremental milestones, how to communicate them to the public, and what legal liability the State may incur by promoting these short-term targets publicly. WSDOT managers also may consider alternatives and adjustments in the engineering solutions to problems, in the methods of service delivery, and in the construction materials and techniques to be used in order to address these short-term targets. These options help to achieve stated targets within current funding and other resource constraints and thus maintain consistency between short-term program accomplishments and long-term aspirational goals.

Technical Resources

The presence or lack of forecasting tools can influence greatly the sophistication of forecasted targets. Agencies that have used HERS, PONTIS, and other tools for forecasting the results of long-term programs have greater insight with which to set long-term targets.

Availability of analysis tools to identify performance impacts of projects realistically and efficiently and to track performance in relation to targets will determine what measures and targets can be used. Sometimes agencies develop desired measures and targets, even when data are not yet available, as a means of creating a "wish list" of data sources. Often it is difficult for decision-makers to see the need for data collection for a single performance metric, particularly if it appears to be part of a single endeavor (e.g., a long-range plan); if it is part of a larger, comprehensive PBRA process, however, it is often easier to justify additional data needs.

Evolution of tools over time makes it very difficult to track progress consistently. Change over time in tools, data, and analysis procedures, as well as differences between agencies and jurisdictions, can make it difficult for stakeholders—and even internal staff—to properly interpret the results. Staff turnover also can exacerbate this situation. Agencies must develop ways of maintaining their institutional knowledge base to properly utilize evolving tools and procedures.

> Those with strong forecasting capabilities are more apt to have long-term goals and targets, whereas companies with weaker forecasting capabilities are more inclined to set annual targets only. For example, Corporation X, which has a robust financial modeling system, sets targets for several forecast periods.

Development of strong tools and data give agencies the ability to not only calculate targets in a rational way, but the ability to measure progress towards those targets or the resources necessary to reach them. These abilities lend credibility to agencies with their stakeholders and the public (MTC). However, tools are often not equipped for a rigorous performance analysis at the project level for long-range planning or comparison between modes.

Organizational Structure

The organizational structure of an agency affects the structure of that agency's PBRA program and process as well as the development and purpose of targets. Centralized organization can allow the central office to work directly with the state government and stakeholders to establish targets. It also allows the organization to handle a somewhat complex and involved target-setting process (WSDOT).

> Private companies with multiple business units often hold up the highest-performing business unit as the benchmark that the others should strive to beat. The element of competition is often more important than the specific targets, so some companies let their divisions have a broad role in determining which metrics to use.

Conversely, highly decentralized structures result in possibly different targets (and different resource allocation priorities and decisions) for different measures in different districts, but with broader and more flexible measures and targets at the central office (FDOT). This structure requires a strong but flexible performance management system to ensure consistency across districts in terms of achieving statewide goals. FDOT's overall Business Plan seeks to maintain accountability and transparency for processes that may not be standardized across the department.

Stakeholder Expectations

Similar to political and legislative influence, stakeholder influence can have a very significant impact on target setting. When external stakeholders become engaged in the process, they can influence the development of goals, measures, and targets. Typically, the use of specific targets derived from an internal process is seen in agencies with a more sophisticated and well-developed PBRA system that has developed over several iterations. Staff resources and, time permitting, an internally developed process can lead to very meaningful and effective targets within an agency's PBRA process.

Agencies often establish targets through a committee process that provides for stakeholder input. As such, it provides an opportunity for dialogue about the transportation issues, constraints in funding, and other topics, which leads to the development of realistic and meaningful targets. This is absolutely critical for state DOTs and MPOs who make decisions in a very litigious environment. It is critical to communicate not only the lofty, long-term goals for transportation systems but the reality of fiscal and political and regulatory constraints as well; this will allow for stakeholder expectations to be managed from the beginning. Keeping flexibility in the target-setting process also is critical in properly setting stakeholder expectations. Further, transportation

is a long-term business, with performance typically improved over the long term, but agencies operate in the context of short-term politics, which can have a very strong impact on performance-based management.

Internal Support/Culture

A common theme among many agencies with more developed PBRA processes is internal support and an inside "champion" at a high level, such as a top-level executive in the agency (MTC, Hennepin County, Mn/DOT). The champions guide the development and implementation of Performance Management, including provisions which help assure that the new way of doing business transcends administrations and individual staff. As a result, these managers understand the importance of PBRA and are willing to ensure the process has the necessary resources to proceed, such as funding, staff, data, and tools.

> In companies with a competitive spirit, the attitude about the numbers is more important than the numbers themselves. In companies with an analytical culture, data collection and analysis is revered and viewed as synergistic with continuous improvement. Corporation X has both budget targets and continuous improvement initiatives, and meeting the operational targets in the continuous improvement programs ensures hitting the budget targets.

Leading agencies facilitate a sense of ownership and responsibility for performance measurement and integrate the practice into an overall agency culture of performance (Maryland DOT SHA). One way this can be achieved is by designating a performance measure "lead" who is responsible for maintaining and reporting data for a particular measure and ensuring data accuracy.

Step 3—Select the Appropriate Approaches for Target-Setting

There is a wide range of agency implementation of PBRA processes, and an equally as diverse range of implementation approaches for target-setting as an element of PBRA. The target-setting approach is determined largely by the factors influencing target-setting and evaluated in Task 2; the appropriate approaches can be selected with consideration of these factors as shown at the end of this section (Figure 1.2).

In practice most agencies will use a hybrid approach (different approaches for different measures but also multiple approaches for a single measure). For example, an agency could use modeling combined with customer feedback to arrive at a target that is both analytically grounded (to ensure a connection with predicted outcomes based on resources and existing plans) and satisfactory to the public and stakeholders. This often helps to mitigate risks inherent in any single approach.

Edict

In the private sector, this approach also is called "Ready-Fire-Aim:" just state the goal and have everybody try to hit it (MNC). The underlying principle of this approach is that success in hitting the target is entirely a function of motivation and execution and that planning is a relatively minor part of reaching the target. The advantage of the Edict approach is that the target is unequivocal and well-understood throughout the organization. The challenge is that the approach is not

	Edict	Expert Opinion	Customer Feedback	Benchmarking	Modeling
Political/Legislative Influence	Varied	Strong	Strong	Varied	Varied
Customer Service Focus	Low priority	High priority	Highest priority	Priority	Priority
PBRA History/Evolution in State of the Practice	Shorter history	Varied	Longer history	Varied	Longer history
Commitment to Regular Communication and Reporting	Low priority	High priority	High priority	Priority	Priority
Span of Control/Agency Jurisdiction	Limited/focused	Broad	Broad	Any	Limited modes
Financial Resources	Few	Few	Strong	Medium	Strong
Timeframe	Varied	Varied	Varied	Short	Varied
Technical Resources/ Planning and Forecasting Capability	Low	Low	Low	Medium	Strong
Organizational Structure	Very centralized	Varied	Varied	Varied	Varied
Stakeholder Expectations	Low priority	High priority	High priority	Priority	Priority
Internal Support	Low priority	High priority	Priority	High priority	Priority
Types of Resources to be Allocated	Internal funds and staff	Funding for projects/programs	Funding for projects/programs	Varied	Funding for projects/programs
Culture	Less oriented to PBRA	Stakeholder-oriented	Customer-oriented	Competitive	Technical

Figure 1.2.   Selecting a target-setting approach based on influencing factors.

inclusive or consultative; it is more characteristic of old-fashioned hierarchical leadership. For example, the choice of metrics and targets is made by senior management and is not subject to discussion. Staff members are tasked with developing a transportation investment plan to meet the target and conducting modeling and technical analysis needed to demonstrate attainment of the target under a future funding scenario. While such an approach is sometimes used by elected officials or other decision-makers to prescribe a target for an agency, this approach by itself is usually unsuitable for most public sector organizations where transparency is expected.

Expert Opinion

In many cases, transportation agencies develop targets through an internal or external consensus-based planning process as part of a more comprehensive PBRA exercise. Typically, the use of specific targets derived from such a process is seen in agencies with a more sophisticated and well-developed PBRA system that has developed over several iterations. Staff resources and time permitting, such an approach can lead to very meaningful and effective targets within an agency's PBRA process. Such a process is usually informed by internal staff analysis, but ultimately approved by an agency's executive management and stakeholder committees.

> The MTC sets overarching goals and strategies for long-range planning at the executive level, a stakeholder subcommittee of the MTC Planning Committee derives the measures and targets with staff input, and the MTC Planning Committee votes on and approves measures and targets.

This approach leverages the technical, practical, and local knowledge of members of the agency and stakeholders within the agency's jurisdiction. Not only does this help to ensure that targets will reflect local and stakeholder priorities but also that they will better reflect "on the ground" reality.

Customer Feedback

Under this approach, direct feedback on system performance and objectives for transportation investment are gathered from the transportation system user through a variety of survey and outreach methods. This feedback is then used by the transportation agency staff to develop specific measures and targets that are closely aligned with the needs of the traveling public (the "customer").

Those agencies that have taken a clear customer-service approach within the resource allocation decision-making process understand the need to use targets that communicate to the system user (the "customer") the return on their investment. Customer satisfaction is a fundamental aspect of performance for these organizations and permeates the process for how potential investments are evaluated and selected to receive funding.

Agencies can use dozens of different types of outreach tools and then analyze the customer input for trends and priorities (Coral Springs, Florida). Tools include annual surveys, public hearings, blogs, regular visioning exercises and focus group discussions, a complaint tracking system, and employee surveys. Selected processes should be extensive, formal, iterative, and continuous.

Hennepin County, Minnesota, utilizes a balanced scorecard (BSC) with the "customer" as one of the four perspectives that the approach is viewed from as part of the PBRA process. In the transportation service area, a number of specific targets already exist and include targets related to bridge and pavement sufficiency ratings, reducing crash rates, completion of the Bicycle System Plan, and project delivery standards.

The target-setting process is still informed by and supported by transportation practitioners that provide the appropriate context for establishing targets (e.g., what percentage of crashes might be expected given certain funding levels, or how much speed may decrease as a result of traffic calming measures), but ultimately processes oriented towards the customer are driven by the customer perception of what needs to be improved and by how much; the way in which measures are reported reflects this. Essentially, this process is almost always part of a hybrid approach supported by Expert Opinion or Modeling.

Benchmarking

Benchmarking as a target-setting approach provides a transportation agency with the means to establish targets in a relatively quick and efficient manner that can be realistically achieved. Under this approach, criteria should be set for peer group selection and analysis, such as similar investment approaches, jurisdiction, span of control, and agency size. In terms of stakeholder expectations, it is often appropriate to select peers that also excel in the specific goal

areas being benchmarked against. Once the peer group is set, practitioners should review each state's performance measures and targets and the degree to which those states are achieving their targets. The comparison among states will help guide the final determination of targets within selected performance measure categories.

Agencies sometimes benchmark against other agencies in the region (MDOT, SHA). National datasets can often provide good compilations of data for benchmarking. The AASHTO Standing Committee on Quality, recently renamed the Standing Committee on Performance Management, conducted a study in 2007 which identified best practices for highway project delivery times and cost. The committee also has identified best practices for smooth pavements. The Austroads National Performance Indicators (NPI) system includes dozens of indicators in 11 broad groupings, covering safety, asset management, environmental impacts, system capacity, user satisfaction, and project management, among other things. The NPI data system presents consistent and comparable data across a transportation system managed by nine separate agencies in two countries, allowing unprecedented benchmarking possibilities.

In the private sector, the following are the three basic varieties of benchmarking:

- **Best-in-Company** benchmarking fosters competition between operating units on the basis of the key metrics and best-in-company performance levels (DIY Company).
- **Best-in-Industry** benchmarking analyzes the performance of companies in the same industry or segment and highlights the best in the group as the benchmark, even if its activities are not directly comparable to the subject company.
- **Best-in-Class** benchmarking analyzes the performance of a broad range of entities, including some with unrelated activities, and highlights the best in the group as the benchmark, even if it is in a different industry than the subject company.

Additionally, strategic benchmarking can identify similar companies' strategies as a basis for setting one's own strategy. Organizational benchmarking can be either qualitative or quantitative. One common form of organizational benchmarking is measuring staff levels used to service a given level of activity.

Finally, benchmarking within the public sector also can include benchmarking against forecasted targets for other agencies, as opposed to just benchmarking against actual best practice performance. The MTC uses several environmental targets that are based on California state goals, but they are not required for the MPO.

Modeling

Both top-down and bottom-up modeling are used to set targets in many companies. Top-down modeling most commonly drives the target by high-level requirements. Top-down modeling determines the strategies or funding needed to achieve the target; Bottom-up modeling determines what level of performance is possible, and then uses that to calculate the expected target (MLIT).

The exact use of modeling depends to some extent on the way in which an agency is utilizing PBRA. For what part of the investment process is the agency setting targets? For example, are they annual financial targets, long-term targets for a long-range transportation plan, or mid-term targets for a package of projects and programs to be included in a TIP?

Table 1.2 summarizes different tools used for modeling performance and estimating targets. These range from simple interpretations of historical data, straight-line projections (Mn/DOT), and analysis of research results; to more complex (and expensive) travel demand and economic impact models. Corporation X uses a sophisticated operations and financial model that

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Table 1.2.   Tools for modeling performance and estimating targets.

Type of Tool	Sample Tools	Advantage	Disadvantage	Type of Outputs
Historical data	Microsoft Excel spreadsheets, Enterprise Resource Planning (ERP) systems.	Easy to use.	Static. Does not consider future growth and change.	Line plots.
Projected trends	Microsoft Excel spreadsheets, SAS, STATA.	Easy to use.	Static. Based almost entirely on historical performance.	Regressions.
Travel demand model	–	Dynamic and allows for testing of projects and scenarios.	Data and resource-intensive. Can be over-relied upon.	Link and system volumes, speeds.
Postprocessors	IDAS, TREDIS.	Provide numerous metrics that are normally difficult to calculate at system level.	Require a travel demand model.	Travel time, delay, crashes, emissions, employment, GDP, Value-added.
Economic	HERS/ST, AssetManager NT.	Input data already required by states Tradeoffs.	Static. Relies entirely on HPMS input.	B/C, delay, crashes, highway deficiencies.
Economic impact tool	REMI, IMPLAN.	Broader, societal measures understood by all.	Requires reliable inputs. Easily misinterpreted.	Employment, GDP, Value-added.
Research	Microsoft Excel, Access, or similar Financial Model.	Emerging areas.	May not be based on actual practice.	Benchmarks.
Management systems	PMS, BMS (PONTIS, Arivu, StreetSaver).	Tradeoffs. Database.	Siloed.	Prioritization, needs.

calculates the impact of seven operational variables on three key business unit and corporate financial metrics.

Many agencies have found innovative ways to incorporate performance-based processes and targets into their planning processes and duties, supported by modeling. The MTC uses its own StreetSaver® PMS to calculate preventative maintenance funding targets for its local jurisdictions; the ratio of "actual versus targeted" determines the jurisdiction's performance score and is a factor in calculating the amount of funding that will be allocated to that jurisdiction.

Modeling is often used by agencies to evaluate progress towards targets, even when modeling itself was not used to establish the target itself. Project and policy scenarios can be tested using travel demand models, combined with other postprocessing tools to include metrics such as benefit/cost, to evaluate their relative contribution to progress towards targets. Section 3.4 of Volume I provides an in-depth discussion of the role of economic models and management systems in target-setting and tradeoff analysis.

Summary of Approaches

Each agency or organization must select the appropriate approach or approaches for its circumstances. Figure 1.2 summarizes how various factors influence the types of approaches an agency may choose; Table 1.3 summarizes the advantages and risks of each approach.

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Table 1.3.   Managing risk of target-setting approaches.

Target-Setting Approach	Advantage	Risk	Approach to Balancing Advantages with Risks
Edict	• Less time and money intensive. • Unequivocal and well-understood.	• Lack of defensibility and inclusion.	• Use hybrid approach.
Expert Opinion	• Insures broad understanding and acceptance within and outside agency.	• May flounder in effort to be inclusive.	• Appoint internal champion to lead effort to identify the "critical few" measures and targets.
Customer Feedback	• Insures more transparent process.	• May be confusing to discuss technical measures with public.	• Describe measures and targets in the simplest terms possible.
Benchmarking	• Provides a peer group comparison.	• Can be misused for comparative rankings.	• Continue to refine comparative analysis techniques.
Modeling	• Defensibility. • Better understanding of future performance.	• More time and money intensive. • Models change over time.	• Continue to refine modeling techniques. • Use hybrid approach.

Step 4—Establish Methods for Achieving Targets

Public and private organizations use several specific methods geared towards helping an agency achieve established targets. Most critical to this, in broad terms, is the integration of performance measurement into daily agency practice. This directs attention to key issues, promotes financial resources for PBRA, and provides the ability to develop stronger PBRA systems.

Incentives

The MTC allocates funding to jurisdictions based partly on progress towards roadway maintenance targets, which are set through a modeling approach. The MTC examines each jurisdiction within the MPO to see how much of their budget is allocated to preventative maintenance projects and compares that to their unique target ratio of preventive to total maintenance as determined by the StreetSaver® PMS tool. Jurisdictions with good pavement conditions will have a higher preventive maintenance target than those with poor streets since the aim of preventive maintenance is to keep the good streets good, thereby reducing long-term costs. Their ratio of "actual versus targeted" determines the jurisdiction's performance score and is a factor in calculating the amount of funding that will be allocated to that jurisdiction. The allocation of regional funds conditioned on preventive maintenance is 25 percent.

In the case of the Kansas State Department of Education (KSDE), Federal No-Child Left Behind legislation presented Federal targets for the state to achieve. The KSDE ties its own state-level targets, which complement the national targets, to accreditation and limited incentives.

Internal employee incentives and sanctions are discussed in the following section on Personnel Performance Appraisal.

Personnel Performance Appraisal

It is important to ensure that each staff person in an organization understands his/her contribution to the mission and that the level of contribution should be part of the staff review process. These organizations have learned to "manage by the measures."

Salary and incentive bonuses, powerful motivators, result in targets that are driven by what people can achieve rather than calculated guesses. Also, compensation that varies depending on performance versus the target is widely viewed as an effective way of motivating performance. Agencies also can use nonmonetary recognitions, even elaborate ones, in order to achieve a similarly high motivational level.

MDOT SHA (Maryland Department of Transportation State Highway Administration) is leading a pilot on behalf of MDOT to base managers' performance appraisals on performance plans that link to office/district business plans as well as individual performance targets. SHA has completely changed its assessment forms to incorporate performance management in these personnel reviews. The assessment now consists of two parts: Leadership competencies (40 percent) and an annually updated Performance Plan (60 percent). Performance is now linked to personnel reviews for staff down to the midmanagement level. For these staff members, the focus is on output measures as opposed to outcome (longer-term strategic) measures.

In the private sector, ABC Logistics uses a Darwinian performance evaluation system that favors high performers and weeds out underperformers through the judgmental application of raises (or the reverse), bonuses, and promotions.

Quality Control and Support

Through continuous tracking of performance and progress towards targets, agencies can identify when problems occur and deal with the shortcomings in a timely manner. Some organizations, especially those with a strong culture of performance management well integrated into most processes, have teams dedicated to performance management and even specific leads for individual goal areas or measures; these groups and individuals can identify shortfalls in progress, work to identify why the shortfalls are occurring, and provide additional support or make other changes as necessary.

> If Maryland Transportation Authority (MDTA) performance is below target (i.e., employee retention and invoice processing time), the Performance Management Team assigns a quality improvement team to work with the division and improve the process and increase performance. At DIY Company, failure to achieve a target results in the invocation of a performance improvement plan.

Tradeoff Analysis

The concept of "tradeoffs" summarizes the main challenge facing transportation agencies—there are more needs then resources available to address them. In this environment, agencies must continually make difficult decisions on which areas of the transportation network to focus their limited resources. Transportation is often a zero-sum game, so additional investment in one area means that an agency must invest less in another. For example, *what* would be the impact on pavement performance *if* pavement funds are increased by 10 percent over the next 10 years? *What* would be the impact on bridge performance *if* this money was shifted from the bridge program? In the context of the overall performance management framework, this type of analysis can help agencies establish relative priorities, set targets, allocate resources, and better manage stakeholder expectations.

Tradeoff analysis currently is limited in public sector transportation agencies. However, Section 3.4 of Volume I provides an in-depth discussion of the role of economic models and management systems in target-setting and tradeoff analysis.

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Competition

Intracompany team competition also is an effective way to motivate performance and establish the right targets based on what can be achieved through competition rather than on a calculated target. Seeing a business unit compete and succeed can stimulate an aggressive response from a competitive peer. Baldrige winners use internal competition extensively to instill creativity and better results.

Availability of Data

Wide and easy access to targets and performance data helps stimulate better knowledge of current performance and performance gaps, hence the ability to improve performance and to do it more rapidly. In contrast, complexity and waffling will dampen attempts to improve performance. Numerous private-sector Baldrige winners plus several Balanced Scorecard users rely heavily on the wide dissemination of performance data inside their companies. Corporation X posts its performance metrics to an intranet where the operating results are available to all users.

Table 1.4 summarizes the advantages and risks of each target-setting approach.

Table 1.4.   Methods for achieving targets.

Method for Achieving Target	Advantage	Risk	Approach to Balancing Advantages with Risks
Incentives	Strong motivator.	Inequalities.	Nonmonetary rewards.
		Could sacrifice performance on one parameter in trying to maximize another.	Use incentives rather than sanctions.
		Incentives or sanctions at program or division level may not fit with public-sector priorities.	
Personnel Performance Appraisal	Strong motivator.	Inequalities.	Team or group bonuses.
	Results in a "natural" target.	Could sacrifice performance on one parameter in trying to maximize another.	Nonmonetary rewards.
Quality Control and Support	Avoids disincentives for not meeting targets.	By itself provides less direct incentive for achieving targets.	Combine with other methods.
Tradeoff Analysis	Optimizes resources for reaching targets	Requires more data and modeling sophistication.	Build capabilities over time.
	Stakeholder/customer understanding of resource constraints.		
Competition	Results in a "natural" target. Stimulates sharing of best practices.	Could sacrifice performance on one parameter in trying to maximize another.	Stimulate internal competition based on a balanced scorecard of metrics.
Availability of Data	Facilitates more improvement ideas.	Education and interaction with peripheral users of the data could derail progress.	Apply varying levels of access permissions.
		Technology to disseminate the information could be costly.	Use web-based gathering and filtering of input.

Step 5—Track Progress Towards Targets

"Measure and Report Results" already exists as an element in the Performance Management Framework; it is the final element before returning back to the beginning of the iterative process. Agencies should explicitly include tracking progress towards targets as part of this element of the Framework; four steps are suggested.

> In the private sector, metrics are shown so that an increase (or moving up on a graph) always indicates a positive result, and percent change is a preferable reporting method.

Tracking

Develop Monitoring Plan

The monitoring plan should address elements such as what specifically is being tracked and if data collection is needed to support target-tracking, what data is to be collected, who will collect it, how will it be collected, where it will be stored, and how it will be reported back to the end-user. The plan should build upon existing data collection efforts (including existing procedures, equipment, and schedules) as much as possible. The plan also should build upon the facts, estimates, and analyses that were conducted as part of planning, programming, and budgeting for this project. These data would have been used to evaluate and rank the project by assessing its proposed improvements to transportation system performance and computing its benefits and costs. These data will now form a baseline for comparison with performance tracking; compiling these data within the plan will ensure that all parties work with the same baseline.

The plan should consider the following possibilities and options:

- **Initial Monitoring Period.** Certain transportation investments have an impact on transportation system behavior immediately upon project completion (e.g., improvements to intersections and signalization). For other investments, the performance improvement is apparent only after some period of time (e.g., the extension in asset life expectancy following preventive maintenance). The plan may need to distinguish between these two possibilities by specifying what measures should be tracked during the initial monitoring of each project: outcomes versus outputs.
- **Outputs and Outcomes.** Ideally, outcomes are tracked to determine whether investments have fulfilled policy objectives and targets. Tracking of improvements in outcomes can begin within the first year for those projects that have an immediate impact on performance (e.g., the intersection and signalization improvements noted previously). For those projects where changes in outcomes are not evident for some period of time (as with preventive maintenance), it may be desirable to include the documentation of output measures as well during initial monitoring. Outputs document the accomplishment of work and the type of solution used (e.g., number of bridges retrofitted with seismic protection, and number of miles resurfaced with hot-mix asphalt versus number of miles chip-sealed). They verify the fulfillment of decisions on method-of-project-accomplishment made during program and budget preparation and provide a quantitative basis for reporting to stakeholders and the public in a period when meaningful outcome data are not yet available.

> Outcome measures such as condition, rideability, and serviceability can be tracked continually for pavements, but they may not show initial-period improvement from preventive maintenance investments since preventive maintenance is performed while the asset is still in good condition.

- **Information Sources.** The Monitoring Plan will encompass a wide range of information sources to cover the several technical areas of the highway investment program (e.g., pavements, bridges, safety, congestion relief, environmental mitigation, etc.) and the need for output as well as outcome measures in some instances. Additional data (e.g., from planning or strategic management) will need to be monitored to analyze external effects.

Track Progress

After the initial monitoring period, tracking of performance outcomes becomes an ongoing process according to procedures in the Monitoring Plan and the defined performance measures. In conducting this tracking, the following two possibilities should be recognized and dealt with if needed.

- **Isolate External Influences.** The purpose of tracking performance in PBRA is to determine the effects of transportation investments. There are times, however, when external factors can confound this relationship. Apparent changes in performance measures that are due to external causes rather than transportation-related actions produce a misleading indication of the benefit of a transportation investment. These external factors may comprise, for example, population and demographic shifts that have not been accounted for, unanticipated changes affecting travel demand (e.g., due to price changes in gasoline), technological changes affecting the vehicle fleet, and catastrophic natural disasters. The effects of these external factors should be isolated wherever possible. Apparent performance trends can be compared to data and assumptions in the baseline estimates to identify anomalies that may signal external influences. Comparison of actual trends (e.g., in population and demographic characteristics) to rates established, for example, by the planning office helps discern where prior assumptions may require change.
- **Reconcile Competing Targets.** Competing targets may create apparent tension in determining the performance benefits of investment decisions. For example, an economic development project to spur commercial activity may increase congestion at locations in the network. This type of issue can be resolved by understanding cause-and-effect, clarifying what is happening, and taking appropriate steps to resolve the situation (e.g., subtracting the costs of congestion from the benefits of increased commercial activity; dealing with the congestion problem through a follow-up project if justified; clarifying and adjusting the specific economic and congestion targets for these network locations to reflect the perceived agency priorities; and proceeding forward).

Develop Findings

After sufficient time has passed to develop reliable performance trends (accounting for the types of checks and adjustments discussed in the previous section), progress towards the performance targets can be assessed. If progress appears to be on track to meet the target, the worth of the project and the merit of the decision to undertake the investment will begin to be verified. Moreover, confidence in the data and analytic models and procedures used to evaluate the project will be strengthened.

If, after applying the checks and adjustments, it appears likely that the target will not be met, a review should begin to try to determine the cause of the divergence. Comparison of the actual

trend with the baseline assumptions and predictions may help to identify where and why the deviation from the intended track has occurred.

Check Validity of Performance Measures and Assumptions

The performance measures and analytic procedures and assumptions should be reviewed periodically for currency and relevance, even when targets have been met. For example, performance measures may need to be updated to reflect changes in policy or governing standards. Assumptions (e.g., regarding population, demographic characteristics, use of different modes, and other factors driving travel demand or supply) likewise should be reviewed in light of current economic, social, technological, political, and financial trends. These are analytic checks and adjustments; the following step describes policy adjustments with respect to the performance targets.

Reporting

Part of tracking progress also involves communicating this performance in terms that are readily understood to the agency's executive decision-makers, other stakeholders, and the public, so they also can track progress towards targets; this is particularly necessary in a collaborative process, such as "Customer Feedback" or "Expert Opinion," in which others are directly involved in the target-setting process. Communicating targets in a manner that makes sense to the general public seems to be a strong indicator for the success of PBRA and the integration of target-setting.

Coral Springs "rolls up" an extensive series of performance measures into 10 key composite measures, referred to as the city's Stock Index, summarizing, at-a-glance, city performance; Hennepin County uses a Balanced Scorecard approach in which numerous measures are evaluated and tracked in terms of multiple perspectives (customer, finance, internal process, learning and growth) and simplified into tables of information providing "warning lights" for areas in need of improvement.

> Setting targets and monitoring achievement of targets is a powerful motivator for behavior: "success breeds success."

Mn/DOT prepares a one-page "snapshot" with performance measures and red, yellow, and green colored shapes to represent annual progress relative to targets, by state and by district. The snapshot graphically illustrates the trend direction and projects next year's forecast. Other agencies use annual attainment reports (MDOT).

Step 6—Adjust Targets Over Time

Performance management is a dynamic process in which performance measures and targets evolve over time. The key to this evolution is periodic assessment of the impacts of the measures and targets on actual investments. The Performance Management Framework itself is an iterative process. Agencies should explicitly include the adjustment of targets over time within the feedback loop of the Framework.

Factors driving a possible need to adjust targets from a policy perspective include the following examples:

- Changes in the level of funding or in rules governing project eligibility to receive certain program funding. These changes can work in positive or negative directions, and program targets may need to be adjusted up or down to reflect these updated expectations of how and where program funding is to be applied.

- Changes in state or Federal policy, or in program priority, as affected by executive or legislative action. Existing performance targets may need to be adjusted, and new targets created, to address new or revised policies and priorities.
- Changes in the behavioral characteristics of the transportation system assets and vehicles. For example, greater use of hybrid vehicles may eventually cause a revision in environmental mitigation targets. Use of innovative materials may allow a refinement of asset preservation targets. Introduction of new inspection technologies may require the creation of new performance measures and associated targets.

When adjusting, agencies also should consider the following items:

- Adjust performance targets only after sufficient time has passed to accumulate sufficient time-series data and to make necessary checks and adjustments, such that a reliable trend has been developed. The trend should provide a fair and reasonable indication of current transportation system behavior and be one that can be supported by facts, analyses, customer surveys, and other sources of information.
- Resolve factors such as model updates, data collection methodologies, etc., that may be influencing the calculation of the target, as opposed to the influence of the actual investment itself (refer to Step 3)
- Account for interagency responsibilities in monitoring and tracking performance [e.g., coordination with MPOs and Regional Planning Organizations (RPOs)]. These interactions should be reflected in the monitoring plan.

Agencies that are only at the beginning of implementing a performance-based process generally have less complete and less sophisticated target-setting processes. In general, there is a typical evolutionary path that agencies follow. A corollary to this evolution is the emergence of an agency's data sophistication.

Iterations of long-range planning cycles (MTC, Mn/DOT), a solid history of performance data, and managerial comprehension and appreciation of that data allows managers to discern what they can or cannot control (WSDOT). During the development of each long-range plan, agencies can reassess what has worked and what has not, adjusting measures and targets accordingly.

Targets can be reassessed on a more frequent basis depending on the level of integration of the Performance Management Framework into an agency's planning and internal processes. MLIT's annual Performance Measures Report/Planning Report monitors the bureau's progress towards its annual and 5-year targets. If targets are not met for a program, then a closer review is performed to determine how the processes for that program may need to be revised, or if a new program may need to be developed to address those performance needs. Conversely, if targets are consistently met earlier than anticipated, target deadlines or measures are reset to reflect more accurate expectations.

Targets at the Maryland Transportation Authority (MDTA) not met are used in lessons learned: the Authority evaluates what happened and why it did not reach the target. The following questions should be asked:

- Were there areas within the target that didn't work?
- Is the Authority attempting to set too high a target?
- Is the Authority measuring the wrong component?

Guide for Data Management

This Guide explains how transportation agencies can use data management and governance to strengthen existing Performance Measurement and Target-Setting programs in the agency. It applies the research results presented in Volume I into practical guidance for transportation agencies. The case studies and examples examined in Volume III were used to produce the guidance.

The Guide is organized under the following headings:

2.1. Establishing the Need for Data Management/Governance.   Data governance is central to continuous improvement. Each private sector case study company noted that data management, data governance, and data accessibility have markedly improved their ability to meet their targets. For example, Corporation X's data governance framework is central to ensuring data of sufficient quality to feed its operational-financial model. ABC Corporation measures its deviations intently. And both ABC, MNC, and Corporation X use data transfer protocols with supply chain partners and governmental entities to collaboratively improve performance.

In support of the need for data governance, this section describes the important relationship between data management and performance measurement and provides a maturity model to assist agencies in assessing their state of data governance. This section is intended to assist data managers in demonstrating the need for data management and governance and prepares them for implementing the strategies described later in the Guidance. The remainder of the sections assumes an agency is committed to improving their data management practices.

2.2. Establishing Goals for Data Management.   Once an agency has committed to making improvements in their data management practices, a plan to achieve this should be formed. This section describes the steps and processes to planning for successful data management.

2.3. Assessing Current State of Data Programs.   In this section, tools and techniques are described related to the first step of the journey—assessment of current data practices, tools, and processes.

2.4. Establish Data Governance Programs.   This section offers guidance for executing and maintaining institutional data management principles based on knowledge gained in Section 2.3.

2.5. Technology for Data Management.   This section suggests technological tools and techniques.

2.6. Linking Data to Planning, Performance Measures, and Target Processes.   This section provides detail related to success factors in this area.

The success factors described in Volume I, Section 4.8 will be referenced in each subsection. The Guide is intended to provide more tools and details to assist agencies in implementing and applying the success factors to achieve successful data management.

2.1 Establishing the Need for Data Management/Governance

The need and urgency for data management improvements are not always shared across all levels of an agency. In some cases, a senior manager within the agency identifies the need, and in other cases, individuals at lower levels recognize the value of improved data management. Nevertheless, a clear case must be established to secure resources and commitment to proceed with a data management improvement strategy. This section is designed to assist agencies in making that case.

The first section covers the relationship between data management and performance measurement in a transportation agency. The second section documents definitions and advantages of data governance techniques. The third section presents a data management maturity model and the final section provides a tool for assessing how well an agency is performing in data management and governance.

The two key success factors related to establishing the need for data governance are the following:

- **Demonstrate the Return on Investment (ROI)** to the organization regarding the use of data management and data governance in order to gain buy-in from executives and decision-makers. Demonstrate with specific examples how the use of data governance can meet the goals and targets most important to executives.

    ROI can be determined in many ways and on many levels within an organization. For instance, in a Highway Safety Improvement Program (HSIP) ROI can be determined in the following ways: (1) from the perspective of the HSIP Statewide Coordinator, an investment in more resources (e.g., people, technology, tools) may lead to the ROI of an improved HSIP strategic plan; (2) for traffic and safety engineers, an investment in Global Positioning System (GPS) field inventory projects may lead to the ROI of improved crash locations; and (3) for the Highway Safety Planning Agency, an investment in electronic data collection may lead to the ROI of improved quality of crash records.

    ROI also can be realized across business functional areas within an agency or across agency boundaries. In the highway crash safety example, ROI can be realized in the following ways: (1) for law enforcement personnel, an investment in electronic crash data collection and submittal may lead to the ROI of reduced time to complete the accident investigation and review; (2) for maintenance and operations personnel, an investment in digital imaging capabilities may lead to a ROI of quicker and less costly asset management inventory and reduced cost to prepare HSIP projects for the traffic and safety engineers; and (3) for the executive management, investment in an enterprise Geographic Information System (GIS) deployment may lead to the ROI for improved tradeoff analysis on project selection by visualizing the crash history, traffic, and pavement condition.

    A data governance framework, implemented on an enterprise level, supports ROI by providing a means of monitoring and tracking progress of various business programs for executives as well as data stewards, stakeholders, and users of the source data. Data governance provides methods, tools, and processes for the following:
    - **Traceability**—aligning data programs with the agency's business needs. Establishing data area communities of interest and working groups that examine needs in common areas and on a regular basis is essential.

- **Performance Measures**—should be reflective of the business needs identified in the traceability exercise.
- **Risk Assessment**—requires the agency to assess (1) how much data is needed, (2) how accurate should the data be, (3) what should the refresh rate of the data be, and (4) who should have access to the data as well as many other questions which help to assess the risks associated with a particular data program.
- **Value of Data Programs**—needs to be demonstrated to users and those who authorize investments in the data programs. This can be done effectively through the use of visualization tools, use of enterprise GIS systems, collecting data once and using it for many purposes, and demonstrated improvements in business operations through the use of quality, accurate, timely, and easily accessible data and information.
- **Knowledge Management**—must become part of the data governance framework in order to ensure that lessons learned and experiences pertaining to business operations within the organization are not lost. This will help to increase the ROI for time and resources committed to support of data programs.
- Formalize a Data Business Plan for the agency or department which identifies how each employee's job is linked to the agency's mission and goals, thereby clarifying the importance of their role in the overall success of the department/office. Corporation X uses a committee composed of the Finance Department, the Capital Committee, and the Performance Measurement Group to monitor the data collection procedures and data revisions, as well as to set data standards and operating definitions.

> A Data Management program strengthens support for performance management in a transportation agency through the use of a Data Business Plan.

Relationship of Data Management and Stewardship to Performance Measurement and Target Setting in a Transportation Agency

Each transportation agency is faced with many challenges and needs regarding the availability of data and information to support business operations. The needs described were identified by Mn/DOT in July 2008, in preparation for the development of a data business plan for that agency. They pertain to the ability of the data programs to support performance measures, target setting, and prioritization of resources in Mn/DOT. Many of these needs are relevant to transportation agencies across the nation and include the following:

- More transparency and accountability,
- More efficient ways to locate and take advantage of available data and information,
- Better methods to look at and integrate data from multiple sources,
- Processes and systems that reduce redundancy and promote consistency in data results,
- More timely and real-time data and information, and
- More department-wide spatial data tools.

One of the ways to address these and other data-related needs is through the establishment of a structured data management program and data governance framework. Data management and data governance can help the agency to prioritize the most critical data needs and identify the resources available to address those needs in a timely manner.

Institutional challenges may include: centralized policy-making and decentralized execution of those policies; limited appreciation by decision-makers of the role of data systems in supporting business operations; and lack of formal policies and standards which guide the collection,

processing, and use of data within the organization. It is particularly critical to have standardized policies and procedures for management of data and information when that information is the foundation of performance measurement and target setting programs for an agency. A data management program is used to coordinate the establishment and enforcement of data policies and standards for the organization.

> Challenges to establishing a Data Management program may be both institutional and technical in nature. However, implementing Stewardship and Governance in the organization supports the overall role of Data Management.

Definitions and Benefits of Data Management, Stewardship, and Governance

Data management is defined as the development, execution, and oversight of architectures, policies, practices, and procedures to manage the information lifecycle needs of an enterprise in an effective manner as it pertains to data collection, storage, security, data inventory, analysis, quality control, reporting, and visualization.

Data governance is defined as the execution and enforcement of authority over the management of data assets and the performance of data functions. The management of data assets for an organization or state DOT is usually accomplished through a data governance board or council. This role is critical in successfully managing data programs that meet business needs and in supporting a comprehensive data business plan for the organization. More information on data governance is included in Volume I, Section 4.3.

Data stewardship is defined as the formalization of accountability for the management of data resources. Data stewardship is a role performed by individuals within an organization known as data stewards.

A **data program** in this report refers to specific data systems that support a business area of the organization. The "program" usually includes the functions of data collection, analysis, and reporting. In the case of a DOT, some examples of these programs include traffic, roadway inventory, safety, and pavement data.

The definitions and examples are covered in more detail in Volume I, Section 4.2.

> A strong Data Management program improves data quality and limits potential risks to the agency regarding loss of critical data and information.

Data Management

A Data Management program is used to do the following:

- Strengthen the ability of data programs to support core business functions of the agency,
- Improve data quality throughout the organization,
- Protect data as an asset of the agency, and
- Limit risks associated with loss of data and information.

Data Governance

The benefits of using data governance can be demonstrated from three different perspectives within the agency—policy, practical and technical.

From a policy standpoint, data governance promotes the understanding of data as a valuable asset to the organization and encourages the management of data from both a technical and business perspective.

On a practical level, the use of a data governance model provides for access to data standards, policies, and procedures on an enterprise basis. It provides a central focus for identifying and establishing rules for the collection, storage, and use of data in the organization.

From the technical perspective, use of data governance results in reducing the need to maintain duplicate data systems, improves data quality, and provides new opportunities to implement better tools for managing and integrating data.

Incorporating some form of data management and governance within the organizational structure of the agency can benefit every transportation agency because their business operations rely on quality data programs for decision-making.

In support of data quality control, Corporation X's dedicated performance measurement group "owns" the data that is gathered by the hardware, software, and processes. In this way it controls the quality of the data so that it is neither too dirty (which would render it useless) nor too pure (which would result in an exorbitant cost).

Data Management Maturity Model

A maturity model is a framework describing aspects of the development of an organization with respect to a certain process. It is a helpful tool to assess where an organization stands with respect to implementing certain processes. A maturity model also can be used to benchmark for comparison or assist an agency in understanding common concepts related to an issue or process. A typical maturity model identifies levels and characteristics of those levels. The model can be used to assess an agency's status and assist in identifying next steps to achieve success towards an ultimate goal state.

> A Data Management Maturity Model is used to assess how the roles of people, technology, and institutional arrangements help the agency to advance from a state that is un-governed to a governed state.

A maturity model was developed here to document levels of maturity related to the development and application of data. The desired end state is the establishment and maintenance of a data governance system that supports performance measurement and target setting within a transportation agency environment. The criteria (people/processes, technology/tools, and institutional/governance) are the following:

- **People/processes**—This refers to the willingness, understanding, and commitment of people within the agency to embrace data management. It also refers to processes that may be in place to assure employees understand and appreciate the value of data management.
- **Technology/tools**—This refers to the use of tools and techniques designed to assist agencies in collecting, integrating, analyzing, and reporting data. More details are provided in Volume I, Sections 3.4 and 3.5.
- **Institutional/governance**—Refers to the institutional structure within an agency to ensure consistent management of data programs. More detail can be found in Volume I, Sections 3.2 and 3.3.

The levels are somewhat generic in nature and are described as: 0—Ad Hoc; 1—Aware; 2—Planning; 3—Defined; 4—Managed; 5—Integrated; and 6—Continuously Improving.

Table 2.1 documents the levels of maturity within the categories. It is assumed that the model will be used to assess the overall status of data management within the entire agency; however, it also can be used to assess the status within a unit of the agency.

To assist agencies in determining where they are in the process, the following characteristics are provided related to each level.

People

0. Management and staff across the agency do not recognize a specific need for a data management program to support performance management.
1. Some personnel in the agency are aware of the need for a formal data management program and/or processes to support performance management but are not involved in developing such a program.
2. Some personnel in the information technology (or similar) office of the agency currently participate in the development and implementation of a data management program for the agency.
3. Work teams have been identified in several offices across the agency to participate in the development and implementation of a data management program.
4. Staff across the agency are aware of the data management program and use the program routinely for the collection and use of data within the agency.
5. Staff across the agency are actively involved in recommending changes for data management policies, standards, and procedures, as business needs change and new performance management goals are identified.
6. People in the agency are fully engaged in continuous improvement related to data management and performance measures.

Technology/Tools

0. The agency does not have any information technology tools in place to support data management.
1. The agency has delegated the responsibility to a specific office, such as Information Technology, to determine what IT tools are needed to support data management across the agency.
2. The agency has implemented some information technology tools, including GIS, data models, data repositories, data dictionaries, etc., to support data management in certain offices of the agency.
3/4. The agency uses information technology tools on a widespread basis, including such applications as an enterprise data warehouse, GIS systems which integrate business data from various offices, and dashboards and scorecards delivered through a web-enabled interface for access agency-wide. The agency uses Service Oriented Architecture (SOA) and Open Database Connectivity (ODBC) in the development of new applications to support future integration of applications.
5. The agency uses a Knowledge Management system throughout the agency to support its data management program.
5. Performance management tools, such as dashboards and scorecards, are used in every office of the agency to monitor the progress of agency programs in meeting the agency mission and goals.
6. Performance measures and targets are adjusted as needed and displayed on the agency dashboard, or similar mechanism, to maintain peak program performance across the agency.
6. The use of technology and BI tools in the agency improves the overall management of programs in the agency, in accordance with the strategic mission, goals, and targets.

Table 2.1.   Data management maturity model matrix.

Level	0—Ad Hoc	1—Aware	2—Planning	3—Defined	4—Managed	5—Integrated	6—Continuous Improvement
Technology/ Tools	No tools in place.	Planning for tools to support data management in some offices.	Planning for tools to support data management across the agency or for a specific office.	Implemented some tools to support data management but not widespread across the agency.	Widespread implementation of tools to support data management but not integrated.	Integrated, widespread implementation of tools to support data management and performance measurement.	Ongoing assessment of new technology to support and improve data management and performance measurement.
People/ Awareness	Not aware of need for improved data management to support performance measurement processes.	Aware of need for improved data management to support performance measurement processes. No action has been taken.	Aware of need for improved data management to support performance measurement processes. Some steps have been made within the agency to improve technology or institutional setting to support data management in at least one office.	Aware of need for improved data management to support performance measurement processes. Some steps have been made within the agency to improve both technology and institutional settings to support data management in more than one office.	Aware of need for improved data management to support performance measurement processes. Improvements are under way to improve both technology and institutional settings to support data management across the agency.	Aware of need for improved data management to support performance measurement processes. Technology and institutional processes are in place to support data management for performance measures.	The agency is able to develop performance measures and predict outcomes for programs based on success with other programs.
Institutional/ Governance	No data governance in place.	The agency is discussing needs/plans for data governance.	Some level of data program assessment and formulation of roles for data managers is underway in one or more offices of the agency.	Data Business Planning underway, including development of governance models for multiple offices in the agency.	Data Business Plan developed with data assessment complete and data governance structure defined.	Fully operational data governance structure in place.	Data governance structure fully supports data management activities across the agency.

Institutional/Governance

0. The agency is not aware of the need for an institutional arrangement or organizational structure to support data governance.
0. The agency does not have strong executive level support for data governance.
0. The agency does not have a Data Business Plan in place to support management of core data programs.
0. The agency does not have defined roles, such as data stewards, stakeholders, business owners (of data), and communities of interest, to support a data governance framework.
1. Agency senior management recognizes the need for a Data Business Plan to manage critical data programs; however, a plan has not yet been developed.
2. The agency is developing a Data Business Plan to support management of strategic data programs.
3. A limited number of offices in the agency have implemented a Data Business Plan to manage the core data programs for their area.
4. The agency has strong executive and senior management support for data governance.
5. An enterprise Data Business Plan has been developed to support management of core data programs across the agency.
5. The agency Data Business Plan has been incorporated into the overall agency strategic plan.
5. Data champions have been identified in each business area of the agency.
5. Communities of interest, which are comprised of internal and external users and stakeholders for core data programs, have been defined.
5. A data governance council or data governance board exists at the agency to direct the data management activities of the agency.
5. The agency has developed and published a Data Governance manual or handbook which identifies the roles and responsibilities of staff in the agency to support data governance operations.
6. The agency has developed a data catalog with data definitions, standards, policies, and procedures for the collection and use of data in the organization. The catalog is available on an enterprise basis through an electronic system such as a Knowledge Management system.

Application of the Transportation Data Governance Model assumes that an agency recognizes the need to embrace and apply data management and governance concepts. The first success factor listed in earlier sections states that an agency should "Demonstrate the ROI to the organization regarding the use of data management and data governance in order to gain buy-in from executives and decision-makers. Demonstrate with specific examples how the use of data governance can meet the goals and targets most important to executives." This can be done by citing examples of other agencies that have certain accomplished levels of maturity with respect to the model. Examples can be found throughout the case studies and examples cited in Section 4.

Planning for Data Management

There are several ways to achieve success with respect to data management and governance to support performance measures programs. One approach is to develop a Data Business Plan. Whether an agency formally refers to their process improvement as a data business plan or not, the following common steps should be taken:

1. Establish goals for data improvement process;
2. Assess data programs;
3. Establish governance programs;
4. Ensure proper use of technology/tools; and
5. Link data management to performance measures and target-setting.

A Data Business Plan helps to do the following:

- Establish goals;
- Assess Agency Data programs;
- Establish Data Governance;
- Ensure proper use of technology/tools; and
- Link Data management to Performance Measures and Target Setting.

Some agencies may choose to implement parts of this list or simply set up and maintain stewardship and governance policies.

The following sections provide more detailed guidance related to these steps.

2.2 Establishing Goals for Data Management

As with any typical planning process, defining stakeholders and setting goals are important first steps. In most cases a champion is responsible for starting this planning process.

The success factors for planning for data management are the following:

- Start with a smaller achievable goal when implementing data governance within an organization and build on small successes to address larger agency goals.
- Use a Data Business Plan to strategically manage data programs similar to other strategically managed programs within the organization.
- Manage expectations of how data governance can help an organization by explaining the benefits of such models for supporting business operations.
- Use Business Models to help executives and managers better understand the relationship between target setting and decision-making.
- Identify champions from Business and IT sides of an organization to support key systems. Partnerships between both areas are critical to successfully managing data programs.

Success factors for Data Management:

- Start small with achievable goals;
- Use a Data Business Plan;
- Manage Expectations;
- Use Business-Use Case Models; and
- Identify Champions.

Recognizing areas for improvement is a key first step in being able to establish goals for a data program. Brainstorming sessions with affected stakeholders is a very effective way to identify both problems and solutions related to data programs. The brainstorming should lead to the establishment of a vision and set of goals for the process.

It also is critical to relate the goals of the data programs to the business objectives of the agency as a whole. This is accomplished through the following steps:

- **Step 1**—Identify the business objectives of the agency.
- **Step 2**—Identify the business functions or services of the agency that support the business objectives.

- **Step 3**—Identify which business functions are supported by which data programs.
- **Step 4**—Establish policies, standards, and procedures which mandate how data is to be collected and used within the agency.
- **Step 5**—Establish Data Action plans on both a data program and enterprise level, to address needs and gaps in data and information across the agency.
- **Step 6**—Establish a risk management plan for protecting data programs as valuable assets of the agency.

Mn/DOT is an excellent example of an agency who conducted a thorough, detailed, and well thought out planning process. They began with the establishment of a BIC which serves as the leadership body for the development and implementation of the data business plan. Its charge was to do the following:

- Craft a vision and mission for managing data and information in the department;
- Develop and implement processes for identifying and prioritizing data and information gaps and needs;
- Identify new data governance principles and frameworks to effectively manage information;
- Develop a business plan that recommends strategies, actions, and resources required to achieve Mn/DOT's data and information vision and mission; and
- Share the data business plan with Division Directors and Commissioner's Staff and assist with the implementation of approved actions and strategies.

The vision and mission was established as follows:

- **Vision**—All Mn/DOT business decisions are supported by reliable data.
- **Mission**—To provide reliable, timely data and information that is easily accessed and shared for analysis, and integrated into Mn/DOT's decision-making process.

The BIC also identified a comprehensive list of issues to be addressed in their Data Business Plan listed.

At the time of the writing of this Guide, the BIC was still working on the rest of these items.

- Once goals for the data management process are in place, the assessment of data programs can begin.

2.3 Assessing Current State of Data Programs

The previous sections provided tools to assess an agency's state of readiness for developing and implementing data governance and laid the groundwork for beginning improvement. Once goals for the Data Management process have been established, an agency should work on clearly identifying and linking data programs to office and agency-wide goals. This section provides guidance related to assessing an agency's data programs, so an appropriate data management improvement strategy can be established. It will assist agencies in conducting surveys, work team meetings, focus groups, or other mechanisms for gathering information regarding customer needs for data programs, agency needs for the programs, and gaps that need to be addressed with a data management program.

A Risk Assessment is a key component of assessing current state of data programs.

This section assists in achieving the following success factors:

- Performing a health assessment of data systems to determine where the most critical deficiencies exist and to develop a strategy for addressing those deficiencies; and
- Performing a risk assessment of existing data programs to highlight the importance of mission critical programs to management and, thereby, gain continued support for those programs.

Identifying Data Programs

The first step in assessing an agency's data programs is to clearly identify which programs will be included in the assessment. Other components include identifying which data products are provided by the data programs and who the providers/users of the data products are.

Most of the time an agency already has identified data systems, databases, data offices, or even data programs. These should be cross walked so all stakeholders can clearly understand how the data systems, processes, and programs interrelate. The identification of data programs also should include a connection to missions and business core services. An excellent example of the result of such a process is shown in Figure 2.1. Alaska DOT&PF linked the overall ADOT&PF mission to the core services, business programs, and primary and secondary data systems.

This is an important step in assessing the value of the programs in terms of meeting high-level agency goals. The process of organizing data categories and relating them to other institutional frameworks within the department is important to the data business planning process for two reasons. First, it allows all stakeholders to clearly see how their data program(s) fit into the overall existing structure of the agency. This ensures buy in for the plan and an understanding of how the data systems fit together and are essential to support the overall mission of the agency. Secondly, an established list of data categories allows for the assignment of data governance roles as described later in this Guide.

Alaska DOT&PF developed a more detailed framework shown in Figure 2.2. The framework links business objectives, programs, and processes to data systems, services, and products. It also starts to define how the data stewardship roles fit in.

It is important to note how Alaska has carefully defined data systems, services, and products. Stakeholders, such as those responsible for collecting data, can quickly see how their institutional systems or reports fit into the overall structure.

Another example, Figure 2.3, illustrates a similar framework used in Virginia.

The Virginia framework clearly indicates the applications that are used to support the data products.

The frameworks should be accompanied with reports defining the systems and relationships. In both of these state examples, reports were generated and distributed to a large number of stakeholders within and outside of the DOTs.

Evaluating Data Programs

To begin prioritizing needs for data programs, they must be carefully evaluated in terms of their ability to meet overall agency goals. For example, traffic and safety data programs must produce quality data to support decision-making regarding safety and mobility projects. Criteria must be developed to assess the data programs. An example of the type of criteria that could be used were initially identified for use with the FHWA's Traffic Data Quality Management Report
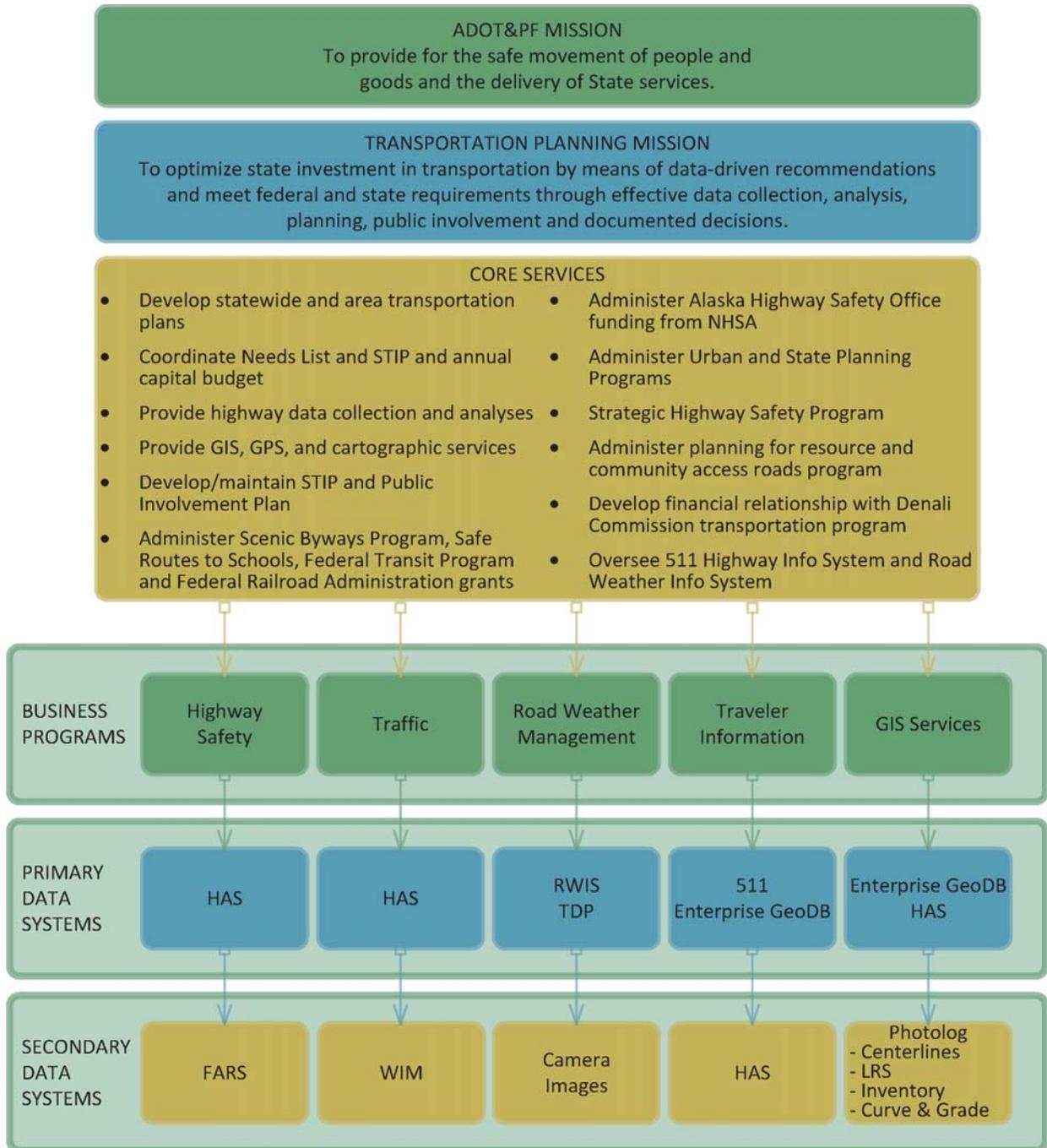
Figure 2.1.   Alaska DOT&PF data development program.

and are applicable, as well, for assessing quality of data used for performance measurement and target setting. These criteria include the following:

- **Accuracy**—The measure of degree of agreement between a data value or sets of values and a source assumed to be correct.
- **Timeliness**—The degree to which data values or a set of values are provided at the time required or specified.
- **Completeness**—The degree to which the data values are present in the attributes (data fields) that require them.
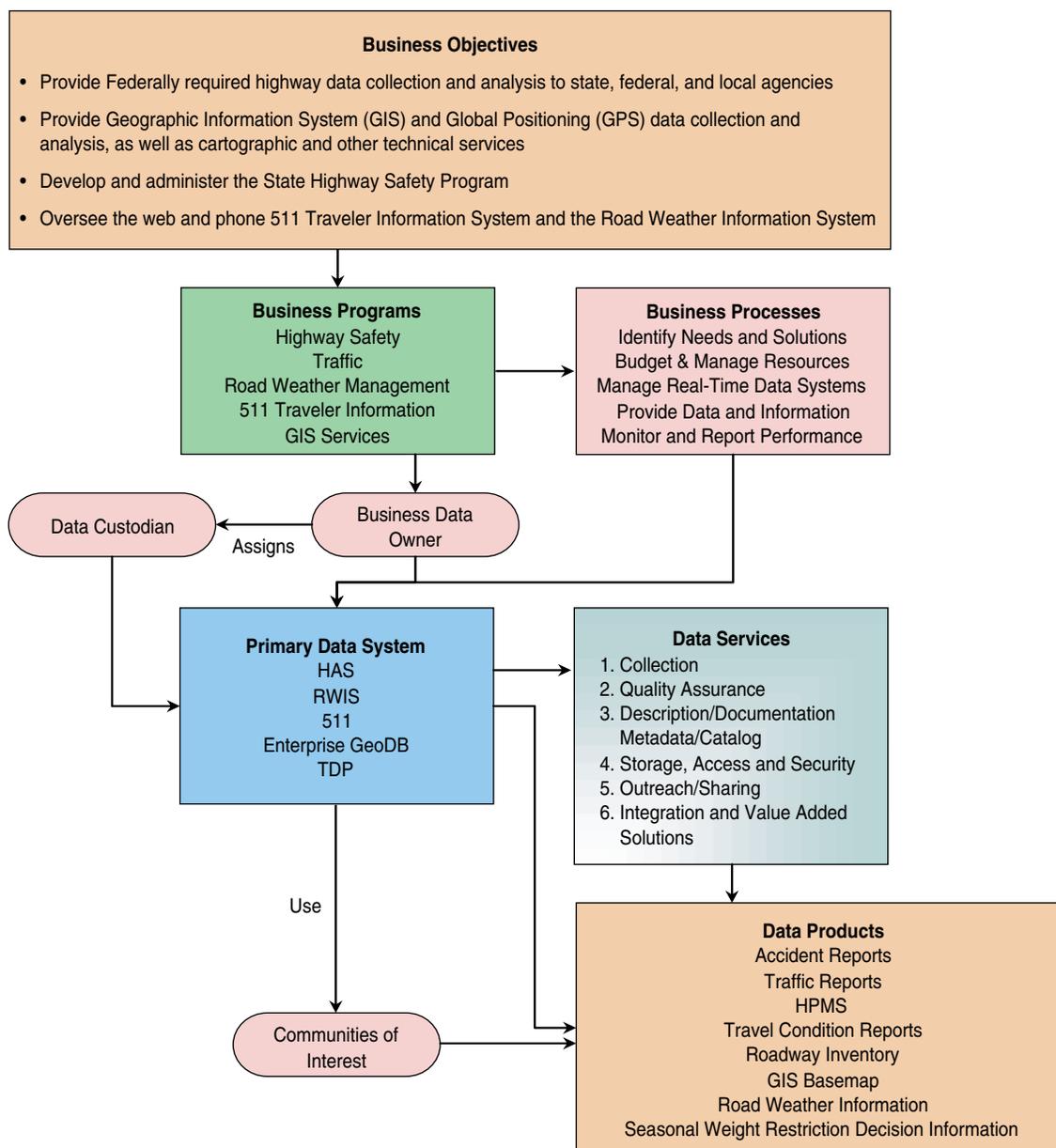
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Figure 2.2.   ADOT&PF data business plan framework.

- **Validity**—The degree to which data values satisfy acceptance requirements of the validation criteria or fall within the respective domain of acceptable values.
- **Coverage**—The degree to which data values in a sample accurately represent the whole of that which is to be measured.
- **Accessibility**—The relative ease with which data can be retrieved and manipulated by data consumers to meet their needs.

For example, these measures helped ADOT&PF identify which data programs were most critical to agency operations and also where data was lacking to meet department needs. The criteria were tested through interviews with key stakeholder groups. The Virginia Department of Transportation (VDOT) used a survey approach to assess their data programs. Mn/DOT also used an agency-wide survey as a valuable tool to begin the assessment process and will provide
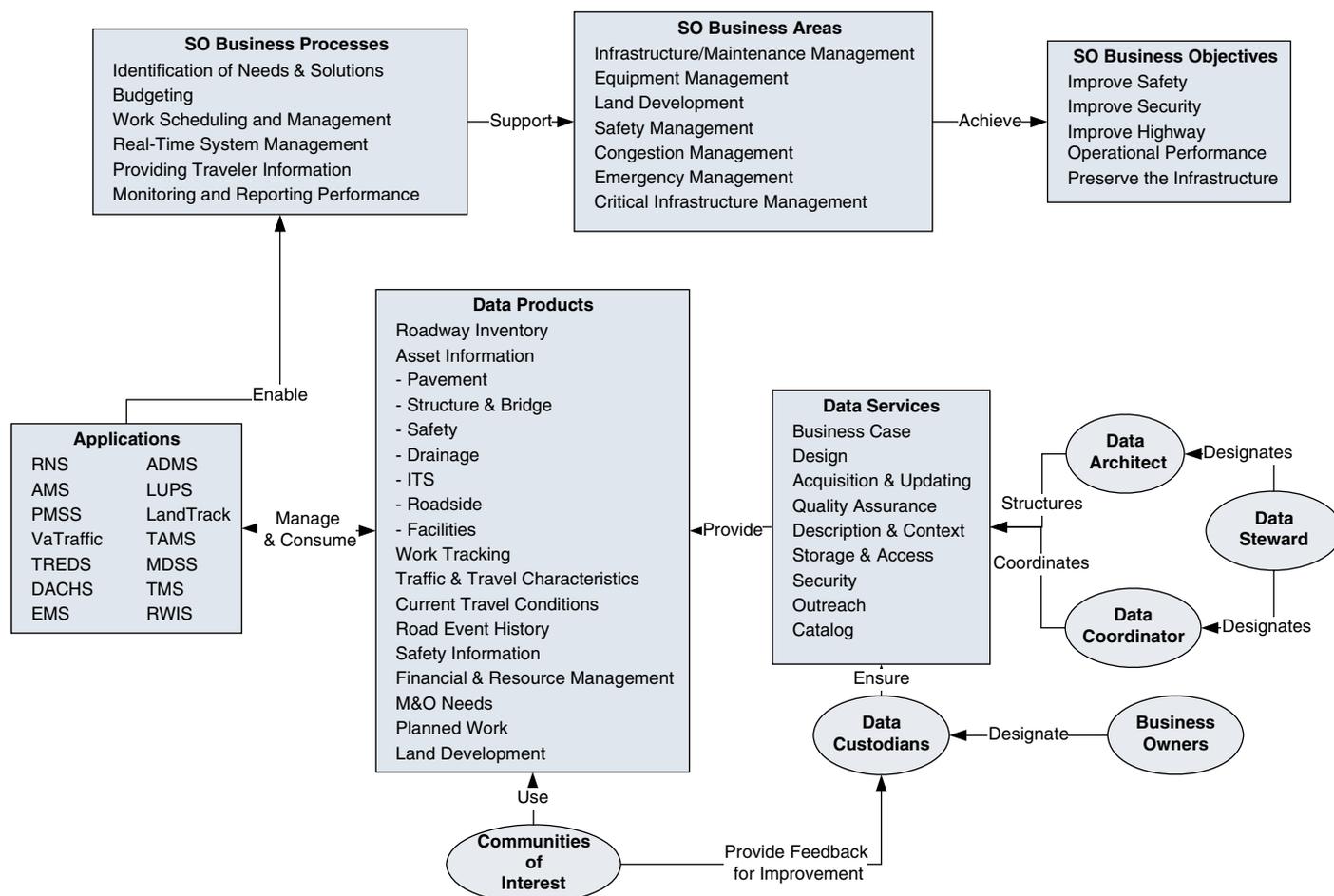
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Figure 2.3.   Virginia data business plan framework.

the basis for further analysis of the data and information needs at Mn/DOT. Completing the assessment helped Mn/DOT do the following:

- Identify data and information priorities to meet user business needs;
- Determine the current ability of data and information to meet user business needs;
- Determine current and anticipated gaps in data and information;
- Identify methods to address current and anticipated gaps in data and information; and
- Enhance user access to information on available data sources and stewards.

The success of the assessment process will depend upon the commitment of the participants to identify what is working well, so those methods can be repeated with other data programs in the DOT. Likewise, this assessment will highlight areas where improvements are needed, to develop a plan of action to address gaps in the data systems.

Instruments for Gathering Feedback

Assessing the current state of data management and data programs in a Transportation agency can be a challenging process, depending upon the size of the organization. However, this process can be expedited through the use of structured methods and instruments for gathering feedback from staff across the organization.

> Develop criteria for evaluating programs and instruments for gathering feedback. This may include the use of:
>
> - Surveys;
> - Focus Groups;
> - Workshops; and
> - Research Studies.

The best approach for the development and use of these instruments depends upon the size of the agency, and the resources and funding available to develop the instruments.

The type of instruments that can be considered for use in the assessment process include: surveys, focus group meetings, data program workshops, and research studies.

The intent of each of these instruments is to gain perspective on the quality of data programs within the organization from the viewpoint of the audience, whether the audience is enterprise-based (using surveys) or a more limited audience which includes participants in focus groups and workshops for specific data program areas, or research studies which may assess data program performance in a specific area such as traffic or pavement.

Surveys

Surveys can be used to assess how well the data programs and information needs of the agency are being met, to identify gaps in needs, and potential solutions for addressing gaps. Surveys provide an opportunity to reach a wide audience with a quick assessment of how well data programs are performing within the agency. Particular attention should be given to developing a survey instrument which assesses data programs across the organization, if the intent is to develop a data business plan for the entire agency. A more limited survey should be used if the data business plan being developed is for a limited division or office of the agency.

Focus Groups

Focus groups offer the opportunity to assess data programs at a more detailed level than surveys. Agencies should include data providers and data users of the particular data program(s) in the focus group discussions. The following are some suggestions regarding Focus groups:

- Use in-depth discussions which focus on specific areas of data and information needs within the organization;
- Develop a list of intended outcomes which are known to all participants, such as a prioritization list and ranking of needs identified for data programs and action plan recommendations for addressing those needs;
- Design to allow for additional pertinent and valuable information to be provided by participants that may not have been previously considered; and
- Reach a consensus on the top three to five data issues that can be addressed over a short timeframe by the agency and also identify those issues that may be addressed as part of a long-term data action plan or data business plan.

Data Program Workshops

Data program workshops can include staff from the Information Technology office of the agency, staff from the business offices who represent the business owners of the data, and other agency staff who represent the data providers and users of the data program(s). Data program workshops are structured to address particular needs identified for a limited group of data pro-

grams or a single data program. The workshops occur after data program needs have been identified and strategies need to be developed to address the data and information needs using a technology solution. This may or may not include the development of new systems and applications or the enhancement of existing applications. Data program workshops can include the preliminary design of new data applications, or data models, and design for integration of existing data and applications into an enterprise model, which better suits the needs of the agency on a widespread level. The outcome of data program workshops can include preliminary architecture and system design for new applications or integration of existing applications within a new framework, such as a GIS.

Research Studies

An agency should consider the use of independent research studies to assess data program performance within the agency, when resources are limited to conduct the analysis internally. Some advantages of research studies include the following:

- Research studies offer an unbiased assessment of the data programs at the agency;
- Research studies can include benchmarking used at other agencies to assess how well similar data programs meet the needs of those agencies;
- Research studies can present proposed methods for assessing data programs and addressing potential problems, based on best-practices across multiple agencies in the private and public sector; and
- Research studies can be sized in scope to focus on limited or enterprise solutions to address data and information needs of the organization.

Compiling and Analyzing Results

Regardless of the feedback instrument used, once the information is gathered on the state of data programs at an agency, the task begins of compiling and analyzing the results.

The agency should perform a preliminary and detailed analysis of the results, in order to develop the best possible solution for addressing its most critical needs regarding data programs.

> Determine gaps in data program needs by analyzing results of data program evaluation instruments.

Preliminary Analysis

- **Step 1**—Compile the raw data from the instrument used.
- **Step 2**—Evaluate the raw data by identifying the data programs which are ranked most critical in supporting business operations.
- **Step 3**—Evaluate whether those programs fully, partially, or do not meet the needs of the agency.
- **Step 4**—Evaluate the gaps in data and information needed as identified by the audience.
- **Step 5**—Evaluate the recommended solutions for addressing the gaps in data and information.
- **Step 6**—Prioritize the recommended solutions.

Once the preliminary analysis is completed a more detailed analysis follows.

Detailed Analysis

- **Step 1**—Evaluate the results according to:
  - Needs within core business areas of the organization;

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  – Needs based on the primary job functions of the audience, within the organization, i.e., senior, mid-level managers, business data stewards, IT data stewards, users of data, and providers of data; and
  – Needs of data programs to support job functions within specific business areas.
- **Step 2**—Evaluate the recommendations made for addressing the critical needs, by business area.
- **Step 3**—Prioritize the data program needs by business area.
- **Step 4**—Prioritize data program needs across the organization, including the most critical needs identified by the assessment instrument. The prioritization process also includes the following additional criteria:
  – Is the data program used to support performance measures and targets?
  – Is the program used to meet Federal or state mandates?
  – Is the program used to support more than one business area?
  – What are the known and anticipated risks to the agency associated with lack of access to data from the data program?

A prioritization matrix should be developed similar to the following example, to identify the top five data programs in terms of these criteria.

Data Program	Value Ranking (Essential, Helpful, Not Needed)	Addresses Key Performance Measures	Used To Meet Federal Mandate	Used To Meet State Mandate	Used to Support One or More Defined Business Emphasis Areas	Risk Level Associated With Data Program
Program A						
Program B						
Program C						
…						
Program Z						

- **Step 5**—Prepare a proposed action plan for addressing the needs of the top prioritized data programs.
- **Step 6**—Submit the plan to senior management for consideration.

Compiling and analyzing results for each data program at the agency helps to facilitate an enterprise gap analysis process, which ultimately is used to develop a data action plan to address data program needs across the agency.

2.4 Establish Data Governance Programs

This section addresses techniques for accomplishing the following success factors:

- Establish, update, and enforce polices and procedures to govern data management.
- Implement a Data Governance Board or Council to address issues related to development, implementation and use of data programs which are critical to supporting business functions.
- Clearly identify the roles/responsibilities of the staff responsible for supporting critical data systems using a Data Governance Manual or other means.
- Communicate with stakeholders to sustain support for various programs. Continue to provide outreach to all communities of interest to ensure that all needs are addressed.

- Manage data as an asset in the organization, through policies governing the collection, maintenance, and use of data.
- Develop a business terminology dictionary to align the use of business terms commonly used throughout an organization. This is particularly helpful to staff such as IT professionals who are often responsible for developing applications to meet business needs.
- Use data standards to do the following:
  - Facilitate establishing targets and measures which meet agency goals;
  - Reduce the cost of multiple data collection efforts and maintenance of duplicate databases. Strive to collect data once and use it many times; and
  - Facilitate consistent reporting of information.

Developing a foundation for data management traditionally relied on policies, standards, and procedures established by an IT division or office. More recently, transportation agencies have instituted a data governing council or board, comprised of senior level managers. This board is generally responsible for establishing the policies and procedures that shall be used in the collection and use of data and information, across the organization, and in support of the agency mission and goals.

The governance board is supported by work groups or work teams whose responsibilities include the following:

- Providing assistance to the governing board in recommending the development of data products to meet business needs;
- Recommending procedures to the governing board for standards and procedures regarding collection, maintenance, and use of data programs and products within the agency; and
- Recommending the technology tools that may be used to support data management at the agency.

The framework in which the governing board and the work teams operate is known as the Data Governance framework. Data governance provides the structure in which a data management program functions. There are a series of steps involved in developing and implementing data governance within the organization.

Step 1—Develop a Data Governance Model

An agency should develop a data governance model that best suits the needs of the agency. There is no single data governance framework that meets the needs of every organization. There is flexibility allowed in how the data governance model is used and over what period of time it is implemented. Some agencies have found it beneficial to start with governance on a limited scale, for a particular office or division, while other agencies decide to develop governance on an enterprise level.

> Develop a Data Governance Model that fits the needs and size of the agency.

A standard data governance model is shown in Figure 2.4.

The participants within the data governance model all have vital roles in supporting the data governance framework for the organization. More detail and examples related to data governance models is found in Section 4.3 of Volume 1.
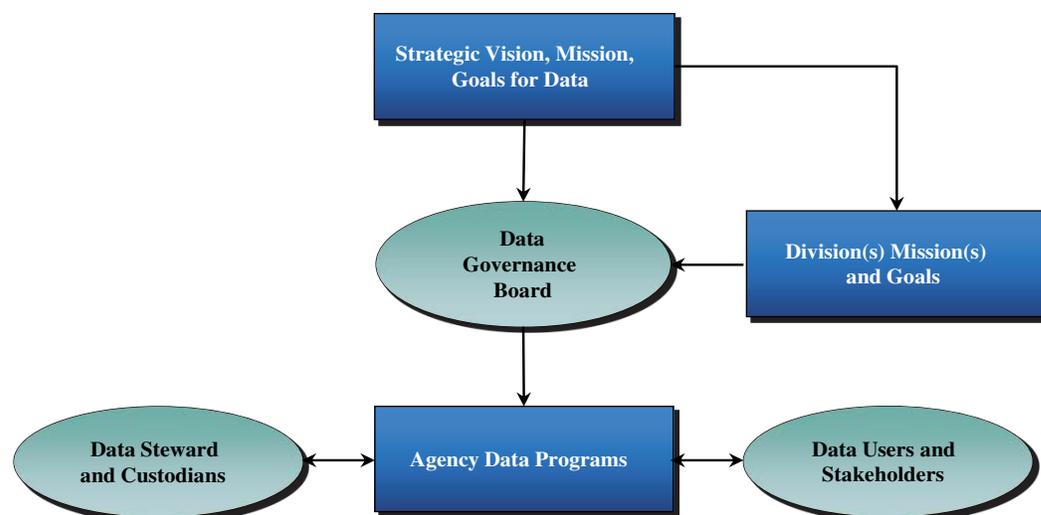
Figure 2.4.   Standard data governance model.

Step 2—Determine Roles and Responsibilities

Each transportation agency should select the roles and responsibilities for data governance that best suits the needs of the organization. Some of the roles may be combined, depending upon the scale of data governance used at the agency. These roles include the following:

- **Data Governance Board or Council**—Serves as the primary governing body for the management of data systems. This governing body is usually comprised of senior level managers who have authority to establish policies for the management of data and information on behalf of the agency.
- **Data Stewards**—Individuals responsible for ensuring that the data which is collected, maintained, and used in the agency is managed according to policies established by the data governance board or council.
- **Data Stewardship**—Data stewardship is defined as "the formalization of accountability for the management of data resources." Data stewardship also can be defined from three perspectives, similar to the three levels or perspectives of data governance for the agency. The three levels of stewardship can be summarized as follows:
  - **Strategic enterprise level**—Data Council;
  - **Tactical level**—Data domains or subject matter experts; and
  - **Operational level**—Data definers, data producers, data users.
- **Data Owners**—Individuals from the business side of the agency that are responsible for establishing the business requirements for the use of the data in their business area of the agency. They also may approve access to data applications supported by their business area.
- **Data Custodians**—Individuals responsible for the technical support of the data applications, including maintaining data dictionaries, data models, and back-up and recovery procedures for databases.
- **Data Architects**—Individuals who define business requirements for data storage and access services and work closely with IT staff to assist with translation of these business requirements into technology requirements (VDOT Data Business Plan, June, 2008).
- **Data Users or Communities of Interest**—The group of persons or offices who share a common interest as users of a particular data program. These can include persons both internal and external to the agency. The Communities of Interest serve a vital role in any data governance framework by providing a focus for communicating business needs which are supported by data programs.

Many of these roles already are being performed by individuals in both the business divisions and Information Technology offices of each agency. The data governance model offers the opportunity to formalize the institutional arrangement between these two entities to facilitate the sharing of data and information throughout the organization.

Step 3—Develop a Data Governance Handbook or Manual

In addition to defining data governance roles and responsibilities, the agency should develop a data governance handbook or manual to provide a single source of information for all staff on the standards, policies, and procedures regarding the use of data and data programs within the organization.

The data governance handbook or manual includes the following components:

- Data governance charter,
- Agency formal data management policy,
- Data governance model diagram used for the agency,
- Roles of data governance participants, and
- Glossary of terms.

Step 4—Develop a Data Catalog

A data catalog can be developed to supplement the information provided in the Data Governance Handbook or Manual. The data catalog includes the following components:

- List of data programs in the agency;
- List of business owners of the data program, with their contact information;
- List of data stewards responsible for the data program, with their contact information; and
- Instructions for accessing data standards and definitions used with each data program.

Step 5—Develop a Business Terms Glossary

Agencies should consider developing a business terms glossary, in addition to data dictionaries, in order to standardize the use of business terms throughout the agency. It is very important for developers of new data applications to use the appropriate data term related to the correct business term when developing applications to support business operations of the agency.

Regardless of the model selected for data governance, and how the agency defines the roles and responsibilities for supporting governance, technology is available to support the data governance framework, by providing mechanisms for sharing and integration of data across the organization. The next section describes some of the available tools used to enhance data sharing and integration.

2.5 Technology for Data Management

In addition to the institutional challenges associated with establishing a data management program for an agency, there also are technology challenges. These challenges impact the ability of the agency to share and integrate data between programs within the agency and to share and integrate data from external sources as well.

Any data management program should include standards, policies, and procedures for data integration and sharing with internal and external stakeholders. Training for staff also is essential for them to become successful in the use of the tools and procedures which support the data management program.

Some of the tools and procedures which can be used to support the data management programs include the following:

- Formal data sharing agreements can be used between internal and external offices in order to facilitate the process of sharing data and information. In order for this process to work smoothly, certain standards and communication protocols must be observed as part of the sharing process. These include the use of the following:
  - Data definitions;
  - Data file structures;
  - Formats used for transmission of data;
  - Frequency of transmission of data updates;
  - Names of persons/offices responsible for transmitting data updates;
  - Names of persons/offices responsible for receiving data updates; and
  - Processes to secure the transmission of confidential data and information.
- Business Intelligence (BI) tools also provide the means for allowing easy access to data systems and sharing of information among employees. These tools may include Knowledge Management systems, GIS systems, dashboards, scorecards, visualization tools, and others, described in more detail in Chapter 4.
- Open architecture should be used in the design of application systems in order to provide for future enhancements or integration with other systems, with minimal cost to the agency.
- Annual data files should be created to be used for reporting purposes, in order to ensure that consistent answers are provided to stakeholders and decision-makers throughout the year.
- Enterprise data warehouses can be used to integrate and standardize the use of data and information within the agency. Standard reports can be exported to Data Marts from the data warehouse and used for analysis of business processes, including reviewing performance measures and targets associated with data programs.
- Hardware such as engine, fuel, and brake condition monitoring systems, GPS, radio frequency identification (RFID) systems, and barcodes helps to gather data from field operations. Corporation X and ABC Company use much of this hardware.

The next sections describe the processes and tools that are recommended for implementing and maintaining a data management plan for the agency.

> Use BI tools to address technology challenges associated with implementing Data Management programs.

Data Sharing

There are many methods and tools used for sharing of data and information. This section provides guidance on the use of GIS systems, dashboards, and scorecards in a public sector agency.

GIS

GIS offer one of the best methods for integrating and sharing data. The integration process involves integrating different types of data in a geospatial data model comprised of several catalogs and tables. Data is then linked to a linear referencing system on a map in order to locate point and linear attribute data.

The advantages of a GIS system include the ability to update data in one part of the GIS model, in a particular table, without impacting other data layers in the system.

The flexibility in GIS tools also offer a quick way to locate anomalies in data through visualization of the data on a map or using 3-D GIS tools.

All state transportation agencies are now required to use a GIS component, known as a shape-file, for submitting the state's transportation network data, as part of the annual Highway Performance Monitoring System (HPMS) 2010 report. State transportation agencies, which are lagging in the development of GIS systems to meet their business needs, should expedite this process in order to support internal data sharing needs, as well as to comply with Federal and/or state mandates.

The process of improving data quality and accuracy of data delivered is greatly enhanced through the use of a GIS system and its associated tools.

Dashboards and Scorecards

Dashboards and scorecards offer another means for visual display of data in an easily accessible and easy to use format.

Some transportation agencies, such as Virginia DOT, have developed dashboards and scorecards for tracking performance measures which assess how well agency programs are performing. The private sector uses dashboards as well; Corporation X has a well-defined one posted to its intranet.

The following definitions explain the distinction between a dashboard and a scorecard. In management information systems, a dashboard is an executive information system user interface that (similar to an automobile's dashboard) is designed to be easy to read.

For example, a product might obtain information from the local operating system in a computer, from one or more applications that may be running, and from one or more remote sites on the Web and present it as though it all came from the same source.

Key performance indicators (KPIs) and balanced scorecards are some of the content appropriate on business dashboards. One of the prominent systems for displaying dashboards is the use of COGNOS®.

The balanced scorecard is one of the components that can be displayed on a dashboard. The scorecard reports on how well specific programs are performing based on targets and goals established which are linked to strategic business objectives.

The purpose of the balanced scorecard is to do the following:

- Align all members of an organization around common goals and strategies;
- Link initiatives to the strategy, making prioritization easier;
- Provide feedback to people on key issues—notably, areas where they can have an impact; and
- Be an essential decision-making tool for everyone in the organization.

The Virginia Department of Transportation (VDOT) provides an excellent example of a dashboard, and their template is recommended by this Guide as a model of how to visually display and implement a dashboard for a transportation agency.

Figure 2.5 illustrates the main VDOT dashboard, which can be used to navigate into more detailed areas of the dashboard, in order to view the performance reporting for projects and programs in the agency. These include Engineering, Construction, Maintenance, Operations, Safety, Finance, and Environment.

One of the main advantages to using this type of mechanism for sharing of data and information is that it is easy to use, and is available to anyone interested in the information, whether it is agency senior management, engineers and support staff, or the legislature and the general public.

In addition to the use of dashboards, scorecards also present a ranking or score in how well programs are performing, in meeting business needs of the agency. Table 2.2 illustrates a balanced
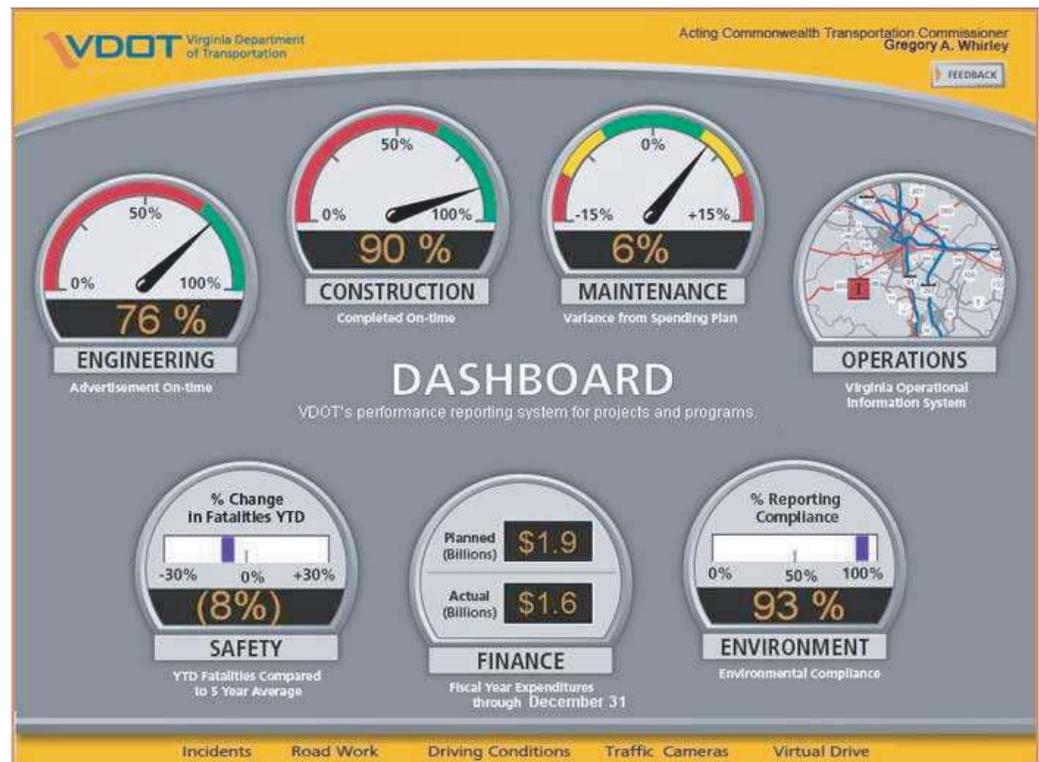
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Figure 2.5.   VDOT dashboard.

Table 2.2.   Hennepin county scorecard.

Perspective	Strategic Objective	Measure	Target	Actual	Comment
Customer	Achieve customer Outcomes.	Number of high-priority issues resolved.	60	30	Need improvement, investigate process for resolving high-priority issues.
	Improve customer satisfaction.	Percent of customers rating service very good or excellent.	80%	80%	Right on Target.
Finance	Manage expenses.	Percent increase/decrease in annual budget.	1.5	5%	Reduced expenses due to budget cuts.
	Maximize revenue.	Percent increase/decrease revenue derived from grants.	5%	13%	Good progress.
Internal Process	Build effective partnerships.	Number of projects involving one or more partners.	25	10	Based on the projects to date with one or more partners.
Learning and Growth	Retain knowledgeable staff.	Employee retention rate.	95%	75%	Need to monitor.

scorecard used in Hennepin County, Minnesota, to monitor programs in the Public Works Department of the county.

Both dashboards and scorecards are an effective means for sharing of data and information as illustrated in Figure 2.5 and Table 2.2.

File Exchange Protocols

Electronic data interchange (EDI) has become a common technology for file exchange. DIY Corporation shares data with its trading partners via the use of automated shipping notifications (ASNs). MNC uses EDI 210 transaction invoice records to interface with its suppliers of transportation services.

Knowledge Management

Transportation agencies should consider using a Knowledge Management (KM) system to strengthen and provide support for their data management programs. A knowledge management system is used to document a wide range of activities, including work processes, which may be solely known to certain individuals. This knowledge, which can be referred to as corporate knowledge is generally considered critical for maintaining business operations. In addition to corporate knowledge, other types of knowledge may be embedded as part of the routine processes and practices of the organization. It is important that this knowledge and these processes are documented for use by future employees and decision-makers.

The benefits of using KM systems include the following:

- KM systems can be used to archive lessons learned which are invaluable when considering future investments in data programs;
- KM systems identify and document the employee networks which are involved in the transfer of information within and between data programs;
- KM systems offers flexibility in the transfer and sharing of data in many different formats, including text, PDF, and digital images;
- The training required in using a KM system is minimal, and they also provide easy to use search and retrieval functions; and
- The cost of implementing a KM system is affordable, and the estimated benefits derived can be used to justify the cost.

Agencies also should consider implementing a KM office to oversee the knowledge management functions of the agency. Depending upon the size of the agency or offices involved, it may be more feasible to implement a section within an office that is responsible for knowledge management activities at that division or office.

Training

The need for training of staff cannot be underestimated as an agency begins the process of implementing its data management and data governance programs. It is normal to expect that there may be some degree of uncertainty on the part of staff who do not understand how their responsibilities may change as a result of implementing new technology, standards, and procedures. Communication is the key to alleviating these concerns. It is extremely important that any agency considering the options recommended in this guide prepare the staff and the audience of stakeholders and users for what is expected during and after implementation of new policies, standards, and procedures. This can be accomplished through on-site meetings, webinars, and on-line/or printed brochures which include Frequently Asked Questions (FAQs) explaining how

such initiatives as a data management and data governance program will be implemented and used at the agency.

Bidding, Auctions, and Cost Management Solutions

A variety of bidding, auctions, and cost management solutions help to manage disaggregated data in decentralized locations. Bidding and auction software helps to keep costs low when negotiating an agreement, and sometimes on the spot market as well. MNC Corporation uses this software when it is time to contract with its vendors.

> Invest in the staff through training opportunities. This will support the ROI for Data Management programs at the agency.

2.6 Linking Data to Planning, Performance Measures, and Target-Setting Processes

The final step is to fully integrate an operational data management process with the agency performance measures and target-setting process. The success factors to achieving this final step are the following:

- Use a hybrid approach employing modeling and benchmarking to establish agency targets and performance measures.
- Do not use a one size fits all approach in establishing performance measures and targets. Use the correct metrics for making decisions. Focus on continuous improvement by revising/adding new metrics as needed.
- Link the performance measures and targets for a program to budget allocations, improving participation by staff in supporting the performance measures and targets. The performance measure and target-setting process also can be used to motivate employees by linking their performance plans to objectives identified in specific performance measures and targets.
- Allow the DOT transportation planning staff routine access to other planning offices (regional, district, etc.) and technical resources available in the agency. This strongly enhances a performance-based management process.
- Reward business areas which consistently meet targets and goals. Consistent achievement in meeting targets is a powerful motivator for behavior—success breeds success.
- Use external data sources, such as environmental, historic, and other planning agencies for GIS data layers to improve the data used for the performance measurement process when funds are limited to collect this data using internal resources.
- Utilize software that is procured or developed internally to automate as much of the performance measurement process as possible. This will allow for more time devoted to the analysis of the performance results.
- Revise or stop using targets if performance data are not easily obtainable when a performance target is used.
- Programs which do not have a direct link between that program or project and performance should not be funded.
- Identify business units responsible for maintaining current metadata about each performance measure. This facilitates the analysis required for user requested data and information system changes and enhancements.
- Include objectives pertaining to resource allocation in the agency Business Plan. The current Business Plan at MDTA, for example, has three separate objectives related to resource alloca-

tion. These include System Preservation, Implementing and Asset Management System, and Integrating MDTA's financial system with other systems.

- Use external data sharing agreements to obtain data for performance measures that the agency does not have. For example, MDTA collaborates with other agencies for several measures that it needs additional data for or does not have the necessary equipment to monitor itself.
- Establish performance targets through a streamlined process and revisit and revise (as needed) periodically.
- Incorporate customer satisfaction as a measure in setting performance targets.
- Utilize incentives to facilitate meeting performance objectives, including awarding bonuses based upon job performance and using quantitative objectives embedded in professional employees' annual objectives.
- Arrange performance measures in a hierarchical order, allowing an agency to translate strategic goals/objectives into operational goals/objectives for each department. The U.S. DOT follows this approach among its various administrations (e.g., FHWA and FTA), allowing it to provide a performance budget that can be related to actual and planned accomplishments for each department. This same scenario would apply to a state DOT, with several divisions, districts, and/or independent offices. The performance in each area then becomes a key basis of resource allocation and budgeting.

A step-by-step guide is not provided for this final step—the requirement approaches will vary significantly across agencies. This Guide is designed to provide helpful advice related to all aspects of data management to support performance measures. It is ultimately up to the transportation agency to take full advantage of the benefits that a fully functional data management process will offer for decision-making in a transportation environment.

It is presumed that agencies are directly interested in linking their data programs to goals and objectives in order that the data programs will support decision-making, including resource allocation and project selection within the agency.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation