



Challenges of Data for Performance Measures: A Workshop

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**Challenges of Data for
Performance Measures**

A Workshop

July 8, 2006
San Diego, California

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A Workshop

July 8, 2006
San Diego, California

Transportation Research Board
Data and Information Systems Section
Performance Measurement Committee

James P. Hall
Editor

March 2007

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Contents

Executive Summary	1
Background	2
Overview of the Preworkshop Questionnaire	7
<i>James Hall</i>	
Key Ideas from the Issues and Challenges in Using Existing Data and Tools for Performance Measurement: TRB Performance Measures Conference	12
<i>Anita Vandervalk</i>	
Data Business Plans in Florida	19
<i>Ysela Llort and James Golden</i>	
What Does Senior Management Need to Know About Data for Performance Measures? ..	22
<i>Randy Iwasaki</i>	
Alaska Department of Transportation and Public Facilities Perspective	25
<i>Jack Stickel</i>	
California Department of Transportation Perspective	33
<i>Robert Copp, Randy Iwasaki, and Debbie Mah</i>	
Florida Department of Transportation Perspective	36
<i>James Golden and Ysela Llort</i>	
Idaho Transportation Department Perspective	39
<i>David Ekern and Gary Sanderson</i>	
Kansas Department of Transportation Perspective	42
<i>Julie Lorenz</i>	
Maryland Department of Transportation Perspective	43
<i>Airon Franklin</i>	
Metropolitan Transportation Commission Perspective: San Francisco Bay Area	45
<i>Lisa Klein</i>	
Minnesota Department of Transportation Perspective	47
<i>Randall Halvorson, Jonette Kreideweis, and Mark Larson</i>	

Missouri Department of Transportation Perspective	54
<i>Mara Campbell</i>	
Montana Department of Transportation Perspective	56
<i>Sandra Straehl and Bill Cloud</i>	
San Diego Association of Governments Perspective	59
<i>Jack Boda and Alex Estrella</i>	
Virginia State Department of Transportation Perspective	63
<i>Jay Styles, Jeff Price, Chris Snyder, and Ilona Kastenhofer</i>	
Washington State Department of Transportation Perspective	67
<i>Daniela Bremmer</i>	
Washington State Transportation Improvement Board Perspective	70
<i>Stevan Gorcester</i>	
 BREAKOUT SESSIONS	
Themes for Discussion	77
Plans and Decisions to Improve Data Systems for Performance Measurement	78
<i>Lance Neumann, Facilitator; Robert Copp, Recorder</i>	
Integrated Systems for Accessing, Analyzing, Displaying and Reporting Data for Measures	90
<i>Jack Stickel, Facilitator; Debbie Mah, Recorder</i>	
Advanced Technologies for Data Collection in Operations	96
<i>Mark Larson, Facilitator; Sandra Straehl, Recorder</i>	
 RESEARCH PROBLEM STATEMENTS	
Developing Performance-Based Investment Programs and Data Systems	103
<i>Randy Halvorson</i>	
Setting Effective Performance Targets for Transportation Programs, Plans, and Policy ..	106
<i>Rolf Schmitt</i>	
Integrating Individual Transportation System-Level Performance Programs to Determine Network Performance	109
<i>Debbie Mah</i>	

Real-Time Transfer of Information to the Customer	112
<i>Linda Cherrington</i>	
Appendix: Acronyms	114

Executive Summary

The TRB Performance Measurement Committee (ABC30) and the Data and Information Systems Section (ABJ00) hosted a workshop to identify ongoing issues and research directions in data management processes for performance measures. Fifteen state and local transportation agencies were selected based on their leadership and interest in the development and utilization of performance measures. Prior to the workshop, agency participants completed an extensive questionnaire on their data collection and data management practices for performance measures.

Results of the completed questionnaires, and subsequent peer exchange discussions, provided insights into current practices. Agencies recognized that data management for performance measures is a complex issue with multiple stakeholders requiring an enterprise approach. Multiple agencies provided comprehensive examples of their enterprise efforts. However, major concerns included data quality, data collection practices, data access, and resource and staffing requirements. Participants expressed the need for quality and understandable performance data, ready access by decision makers, greater state, federal, and local agency participation in data sharing, and more sophisticated tools for data analysis and modeling.

In breakout groups, the peer exchange participants focused on four major interest areas regarding data for performance measures: data challenges, plans to improve data systems, integrated systems for analyzing and reporting data, and integrated data collection. At the end of the workshop, each breakout group presented their top research issues. Upon a thorough discussion of these issues, the workshop participants developed research problem statements to address specific areas of interest. These problem statements included the development of performance-based investment programs and data systems, setting effective performance targets, integrating individual transportation system-level performance programs to determine network performance, and real-time transfer of information to the customer.

Background

PURPOSE OF THE WORKSHOP

The TRB Performance Measurement Committee (ABC30) and the Data and Information Systems Section (ABJ00) hosted a workshop to identify ongoing issues and research directions in data management processes for performance measures. Fifteen state and local transportation agencies were selected based on their leadership and interest in the development and utilization of performance measures. Prior to the workshop, agency participants completed an extensive questionnaire on their data collection and data management practices for performance measures.

The participating agencies were

- Alaska Department of Transportation and Public Facilities (ADOT&PF),
- California Department of Transportation (CalTrans),
- Florida Department of Transportation (DOT),
- Idaho DOT,
- Kansas DOT,
- Maryland DOT,
- Metropolitan Transportation Commission (San Francisco Bay Area),
- Minnesota DOT,
- Missouri DOT,
- Montana DOT,
- San Diego Association of Governments (SANDAG),
- Texas DOT,
- Virginia DOT,
- Washington State Transportation Improvement Board, and
- Washington State DOT (WSDOT).

WORKSHOP OBJECTIVES AND OUTCOMES

The workshop's objectives were:

- Share current practices and those being considered for implementation; to find, collect, and manage existing data sources for performance measurement (PM).
- Identify new data sources or modifications to existing data systems that could better serve PM, while both measures and data systems are evolving.
- Discuss institutional barriers to improving data in support of PM.
- Identify opportunities, including research and other initiatives, that could improve performance measures and the data programs that support them.

Workshop activities included

- Explore specific ways in which performance measures have directed or can direct strategic investments in data program to enhance the quality and availability of information for decision making
- Identify and share examples of how enhanced data methods, tools, and technologies can substantively strengthen PM efforts.
- Identify specific data gaps and priorities for future work and research to improve the information available for PM.
- Identify what data frameworks and methodologies will be needed to take PM to the next level to address questions.

AGENCY QUESTIONNAIRES

Prior to the workshop, each participating transportation agency representative answered four questions to summarize their agency's data collection activities, data management practices and ongoing improvements for the development and use of performance measures.

The questions were as follows:

1. How have you used current data collection activities to feed performance measures?

- a.* How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?
- b.* How has your organization partnered with local governments, metropolitan planning organizations (MPOs), and tribes in developing data sources for system performance measures?

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)?

- a.* How do these plans, or other activities, improve or audit data quality and help users understand appropriate uses and limitations of data?
- b.* How have plans been developed for more complex performance measures such as quality of life and sustainability?
- c.* How do these plans incorporate broader data uses beyond performance measures?

3. How have individual data collection systems been developed or modified to better support performance measures?

- a.* What factors were considered when deciding to invest in data system improvements?
- b.* Who were the key people involved and how was timely consensus reached?

4. How have tools for displaying or interpreting data [such as geographic information systems (GIS) and microsimulation models] been incorporated into the development of performance measures?

- a.* Have existing tools been modified or new tools been developed?
- b.* How has enterprise tool development incorporated performance measures?

WORKSHOP STRUCTURE

Introductory Remarks

Randy Halvorson, Division Director at the Minnesota DOT and facilitator of the peer exchange, welcomed the participants. He reiterated the objectives of the workshop including identification of priority research issues to develop draft research problem statements for the 2008 Cooperative Research Program process.

The peer exchange started with presentations providing an overview of the challenges of managing data for performance measures including executive level perspectives and a presentation summarizing the results of the state agency questionnaires. Subsequently, workshop participants participated in individual breakout groups.

Themes and Discussion Questions for the Breakout Groups

The expected outcome of the group discussions was to provide a basis for research areas to solve priority issues. Breakout groups were composed of the same participants throughout the day. Two hours were allocated for discussion in the morning and 2 h in the afternoon. Groups reserved the final 30 min in the afternoon to summarize and prioritize the issues discussed.

The four major themes of the breakout sessions were:

1. Data challenges for measures. Each breakout participant described priorities for learning from others and what they would like to get out of the workshop.
 - a. What are important measures where are you experiencing problems with data systems and data quality?
 - b. To improve data quality some organizations have agencywide standards and tools, while others delegate it to program areas. What is your approach and why?
 - c. What are your successes or challenges forming partnerships for data collection or shared measures, either internally, or with local and regional governments, or others?
 - d. What data sources might be used for “complex” measures areas such as land use and land value, quality of life, environment, and sustainability?
2. Plans and decisions to improve data systems for PM.
 - a. How and when should organizations develop data business plans?
 - i. When should a data plan be utilized?
 - ii. What criteria are used to select data or information technology investments? Are the criteria related to organizational strategic priorities and measures?
 - b. What are the critical partnerships needed for success?
 - i. What are the roles of planners, information technology (IT) bodies, and executive teams in project selection (internal partners)?
 - ii. Who are the key external partners and how have they contributed to improved data plans and systems?
 - c. How is the quality and accuracy of data maintained or improved as a result?
3. Integrated systems for accessing, analyzing, displaying, and reporting data for measures. Examples: GIS, business intelligence (BI) software, data warehouses—marts, portals.
 - a. When and why should organizations pursue such systems?

- i. Goals and benefits. What is the payoff of integrated systems? How do you quantify benefits?
- ii. What resources are required to develop and maintain systems?
- b. What is your experience to date? Are the commercial BI/GIS packages adaptable and effective? Provide any success stories., where is the greatest payback (data or data analysis category with the greatest value)
- c. What are your biggest obstacles to integrating enterprisewide data for developing decision support tools, e.g., scattered legacy systems, access to historical data, inadequate enterprise data plan.

Related Questions

- What BI/GIS/data warehouse tools (e.g., network analysis, forecasting, predictive modeling, program development, policy analysis) potentially provide the greatest benefits to support performance measures and analysis?
- What approaches are you using to improve predictive modeling? What challenges have you encountered?

Integrated Data Collection for Performance Measures

- a. How are data collection activities being integrated to support performance measures?
 - i. Provide examples of activities underway or planned (success stories).
 - ii. How have business processes been combined? How were these decisions made?
 - iii. What hurdles exist to integrated data collection processes?
- b. How are advanced technologies being used or planned to further automate data collection? [Examples: automatic vehicle location (AVL), Global Positioning System (GPS), remote sensing, automated vans, etc.]
 - i. Provide examples of technology development underway or planned (success stories).
 - ii. Is a long-term technology plan in place to support integrated data collection for performance measures?
 - iii. What hurdles exist to widespread use of these technologies?

The discussion themes were designed to serve as a guide for discussion, with groups having considerable leeway to define issues best based on their collective experience. Each group started with the data challenges theme first. Then each group concentrated on their assigned priority theme in detail. Other themes were discussed as time was available. The individual group assignments were:

- Group 1: Plans and Decisions to Improve Data Systems for Performance Measurement. Lance Neumann, facilitator; Robert Copp, recorder.
- Group 2: Integrated Systems for Accessing, Analyzing, Displaying, and Reporting Data for Measures. Jack Stickel, facilitator; Debbie Mah, recorder.
- Group 3: Advanced Technologies for Data Collection in Operations. Mark Larson, facilitator; Sandy Straehl, recorder.

Workshop Results

At the end of the workshop, each breakout group presented their top research issues based on the discussion. Volunteers were solicited to draft research proposals for the 2008 Cooperative Research Program process. The proposals were further evaluated and refined by the workshop planning group. This process resulted in four distinct research project proposals as follows in priority order:

1. Developing Performance-Based Investment Programs and Data System;
2. Setting Effective Performance Targets for Transportation Programs, Plans, and Policy;
3. Integrating Individual Transportation System-Level Performance Programs to Determine Network Performance; and
4. Real-Time Transfer of Information to the Customers.

The full text of these four research project proposals is included in this e-circular.

Overview of the Preworkshop Questionnaire

JAMES HALL

University of Illinois at Springfield

James Hall presented a summary of the agency responses to the questionnaire. As detailed in the background section, 12 state and three MPO or local transportation agencies completed the questionnaire. The results provided a comprehensive background of transportation agency initiatives and issues regarding the management and utilization of data for performance measures. The following summarizes agency responses to the questions. A more detailed summary of agency responses starts on page 25.

CURRENT DATA COLLECTION ACTIVITIES FOR PERFORMANCE MEASURES

How Do Data Collectors Incorporate Performance Measurement Data Requirements in Overall Data Collection?

- Most agencies use existing data, primarily from functional area–asset management systems.
- Data is typically acquired from legacy systems.
- Some agencies are gathering new data.
- Some agencies are using external data.

Performance Measurement Data Categories

Agency responses indicated a wide range of data categories that were used for PM and analysis.

- Safety, crashes, injuries, and fatalities;
- Pavement;
- Bridge;
- Maintenance;
- Traffic;
- Rail crossing;
- Traveler information;
- Road weather information;
- Urban travel times;
- Construction;
- Project management;
- Program management;
- Work management;
- Seat belt usage;
- Speed studies;
- Rest areas;
- Capacity and safety improvements;
- Workforce;
- Financial system data;
- Spatial identifiers; and
- History.

Is There Any Partnering with Local Governments, MPOs, and Tribes for Data?

Types of External Agencies

- Local agencies;
- State agencies [e.g., Environmental Protection Agency (EPA), law enforcement];
- Federal agencies—benchmarking;
- MPOs; and
- Tribes.

Data Categories Acquired from External Agencies

- Crash data,
- Traffic count data,
- Travel time data,
- Bridge condition,
- Pavement condition,
- Indian Road Reservation data,
- Certified mileage,
- Law enforcement data,
- Customer surveys, and
- Customer case studies.

One MPO responder noted that MPOs are able to add new measures more readily since they were smaller and were able to realign resources and make use of technology improvements more readily.

PLANNING OF DATA SYSTEMS FOR PERFORMANCE MEASURES (DATA BUSINESS PLANS)

Formal Agency Efforts for Data Quality and Data Understandability

Agencies were quite varied in their response to this question. Some agencies had implemented extensive data business plans; others had no data business plan; many were somewhere in between.

- Assigned responsibility of functional area data stewards;
- Align data with mission, strategic plan, or other business plans;
- Document data collection processes and profiles;
- IT project assessment process for new initiatives (resources);
- Technology investment plan—technology for data collection;
- GIS strategic plan—linear referencing systems (LRS);
- Performance team monitors data quality;
- Intranet/extranet access—for feedback;
- Alaska—systems engineering process/concept of operations; and

- Many agencies noted that this is a continuous effort.

Data Quality Factors

- Timeliness;
- Accuracy;
- Completeness;
- Duplicity;
- Understandability;
- Metadata;
- Historical data—need for access and consistency; and
- Data profiles—collection, controls, calculation methods, definitions.

Plans for More Complex Measures (e.g., Quality of Life and Sustainability)

Many agencies noted that this data, such as quality of life data, was difficult to define, collect, and measure.

- SANDAG has some indicators;
- Environmental;
- Air quality;
- Land value;
- Crashes; and
- Traveler satisfaction.

Broader Data Uses Beyond Performance Measures

- Asset management systems—different levels of data integration;
- Many tasks for functional and business areas;
- Intranet access for fact-based decision making;
- GIS integration;
- Performance dashboards;
- Traveler information (511);
- ITS architecture; and
- Communications with legislature, boards, and the public.

DATA COLLECTION DEVELOPMENT AND MODIFICATION FOR PERFORMANCE MEASURES

Factors Considered in Data System Improvements

Enterprise Perspective

- Ability to manage assets;

- Program management;
- Integration with strategic plan;
- Integration with GIS and BI tools;
- Enterprise portal;
- Focus on high benefit areas, e.g. safety, resource allocation;
- Data marts; and
- WSDOT—Critical Applications Modernization and Integration Strategy Project.

Functional Manager Perspective

- Resources—impact of additional work;
- Data accessibility;
- New and feasible technologies;
- Project management capabilities;
- High benefit data, e.g., signs, guardrail, geometrics; and
- Use of data from other local, state, and federal agencies.

Methods to Reach Consensus

- Many agencies still working on consensus.
- Need executive level leadership.
- Need product champion (with clout).
- Performance measure drivers work with data collectors.
- Incorporate in strategic plan.
- Avoid scope creep.
- Prototype—demonstrate the end product.
- Actively involve users and stakeholders—not just a vendor product.

Some agencies indicated that there was some resistance from the perception that decisions were made for the performance measure itself rather than for the greater good of the agency.

Key People to Reach Consensus and Implementation

- Executive leadership;
- IT governance board;
- Committees—executive, technical, steering;
- Working committee;
- Data stewards/experts;
- Middle management/users—some suspicious of report carding;
- Stakeholders; and
- Vendors.

INCORPORATION OF TOOLS FOR PERFORMANCE DATA DISPLAY AND ANALYSIS

New Tools or Modification of Existing Tools

- Most agencies working to integrate legacy data systems and measures with GIS.
- Caltrans—Microsimulation modeling, including forecasting with visualization tools.
- Minnesota, SANDAG, and Washington State Transportation Improvement Board (WSTIB)—performance measure dashboards.
- Multivariate analysis, e.g., land use planning, environmental.
- Videologging.

How Do Enterprise Tools Incorporate Performance Measures?

- Minnesota DOT, WSDOT—BI performance reporting (but software limited).
- Enterprise performance dashboards.
- GIS for display and to serve as a portal.
- Use lessons learned in data analysis for policy changes (WSTIB examples).
- Use tools to build consensus.

SUMMARY

- Complex stakeholders—complex measures, complex issues.
- Good examples of enterprise efforts.
- Need quality and understandable performance measure data.
- Need ready access by decision makers.
- Need enterprise approach.
- Need more sophisticated tools for analysis and modeling.
- Greater need for state, federal, and local agency participation and data sharing.
- Major concerns: data quality, data collection, data access, and resources and staffing.
- Inhibiting factors: data integration issues, spatial linkage capabilities with GIS base.
- Performance measures: changing target.
- There is a general hope that technology will continue to improve in data collection, management, and analysis processes.

Key Ideas from the Issues and Challenges in Using Existing Data and Tools for Performance Measurement

TRB Performance Measures Conference

ANITA VANDERVALK
Cambridge Systematics

Many transportation agencies seek to improve the collection, processing, and use of performance measures without making significant additional investments to collect new data or implement new information systems and analysis tools. The purpose of this presentation is to highlight technical issues associated with using existing data and tools for PM in a transportation agency. The discussion identifies common challenges that are faced, so that agency staff can anticipate and address these challenges in a proactive manner.

PRESENTATION OVERVIEW

- Using Data and Tools for Performance Measures;
- Planning for Performance Measures;
- Gathering the Data;
- Managing the Data;
- Transforming Raw Data into Performance Measures;
- Understanding and Using Performance Measure Information; and
- Issues for Different Measures: Infrastructure, Mobility, Safety, Customer Service, Output.

USING EXISTING DATA

Success depends on

- Processing and checking raw data;
- Transforming raw data into meaningful performance measures;
- Integrating for analysis and mapping;
- Developing trend information;
- Projecting measures into the future for target setting; and
- Providing tools to decision makers.

PLANNING FOR PERFORMANCE MEASURES

- Who will collect, analyze, forecast, and report?
- What are the data requirements?

- Who will use it?
- Where will the reports be kept?
- How will they be illustrated?
- What are the characteristics of success?
- How can success be quantified?
- Is it suitable for public use?

Guidance

- Evaluate candidate measures based on multiple criteria.
- Measure what you can control.
- Integrate with business process.

What's New?

- Continued interest in planning for operations;
- Tools;
- State data business plans; and
- Interstate 95 (I-95) Corridor Coalition Performance Measures Survey.

GATHERING THE DATA

- Is our data collection cost-effective?
- Can we process the data in time?
- Are we collecting more than we need?
- Are we making good use of available technology?
- Are we ensuring data quality?
- Are we facilitating integration?
- Are we respecting the need to maintain valid trend data?

Guidance

- Collect accurate and consistent location reference data.
- Analyze trend data.
- Evaluate use of new technology.
- Consider outsourcing.
- Put data quality controls in place.
- Consider accuracy requirements.

What's New?

- State GIS plans improving.
- Highway Performance Monitoring System (HPMS) reassessment:
 - State geospatial networks;

- HPMS changed to allow “native” LRS; and
- Consistent LRS is needed for all federal reporting—key for data integration.
- More outsourcing—but not a lot.
- Still collecting more data than we can use.
- Starting to integrate ITS and traditional mobility data.

MANAGING THE DATA

- Are we ensuring that performance data is available to those who need it, when they need it?
- Do we have standards for documenting data definitions and sources?
- Are we using the right technology to store and disseminate our performance data?
- Will we be able to maintain continuity with baseline and trend performance information?

Guidance

- Recognize and plan for management costs.
- Manage data as an asset.
- Decentralize.
- Plan for smooth transitions as legacy systems are replaced.
- Nail down data definitions.
- Provide web access to performance data.

What’s New?

- *NCHRP Report 551: Performance Measures and Targets for Transportation Asset Management* released.
- More states on the web.
- XML standards.
- Still need more software and off-the-shelf solutions.
- Integrated Corridor Analysis Tool (ICAT).

I-95 CORRIDOR COALITION ICAT PROJECT OBJECTIVES

- Develop a GIS-based transportation network to support planning activities at the corridor level.
- Develop a geographic LRS to relate transportation data from multiple sources to locations on the network.
- Populate the network using available national, state, and local data on roadway characteristics, capacity, and operations.

ICAT Application: Multistate Volume–Capacity Analysis— Transforming Data into Performance Measures

- Are we using valid methods and appropriate tools to transform or provide information that is meaningful to decision makers or the public at large?
 - Can we automate the calculation of performance measures to speed the process and improve accuracy?
 - Are we maintaining linkages in order to allow for drilling down into the details?

Guidance

- Focus on essential measures.
- Provide methods and tools for drilling down and rolling up.
- Make use of GIS software and office productivity applications
- Ensure accuracy and consistency of fundamental measures.
- Avoid linear referencing pitfalls.

UNDERSTANDING AND USING PERFORMANCE INFORMATION

- Do we have the right methods and tools to predict future performance?
- Do we have the information and tools needed to establish targets?
- Can we do what-if analyses (investment levels and performance)?
- How can we improve our ability to understand the causal factors behind measured performance?

Guidance

- What-if analysis;
- Simulation tools;
- Integrate project and program data;
- Ensure consistent cost assumptions;
- Monitoring;
- Peer comparisons; and
- Determining causality.

What's New? (Or at Least, What's Best?)

- Caltrans: Performance Measurement System (PeMS).
- Washington State: Performance management dashboard.

INFRASTRUCTURE

What's New?

- Safe Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Highway Safety Improvement Programs (HSIP), and Strategic Highway Safety Plans (SHSP);
 - FHWA safety office research;
 - Safety analyst tools; and
 - Safety and mobility.

Strategic Highway Safety Plan

- SHSP needs to be developed by each state DOT.
- Statewide-coordinated safety plan provides a comprehensive framework for reducing highway fatalities and serious injuries on all public roads.
 - Establishes statewide goals, and objectives, and involves private-sector safety stakeholders.
 - States shall have in place a crash data system with the ability to perform problem identification and countermeasure analysis.
 - States must advance the capabilities for traffic records data collection, analysis, and integration:
 - State traffic record systems,
 - Motor carrier data,
 - Driver records,
 - FRA inventory of highway–railroad grade,
 - Transit data, and
 - Road inventories and traffic data.

Data Needs

- Highway inventory data;
- Roadway segments:
 - Route type, identifiers, and location,
 - Geometry (cross section, alignment), and
 - Traffic volume;
- Intersections;
- Ramps;
- Traffic volume data; and
- Crash data.

Data Related Activities: FHWA Office of Safety

- Digital highway measurement system: detailed roadway inventory at highway speeds;
- Roadway safety hardware asset management systems: signs, signals, markings, and

roadside hardware

- Minimum Inventory of Roadway Elements (MIRE).

Highway Safety Analysis Tools

- Developing several analytical tools.
- Analysis tools require more and better data to achieve desired levels of precision.
- Next generation of tools coming online over next several years:
 - Safety analyst (network level analysis),
 - Interactive Highway Safety Design Model (IHSDM)—project-level analysis, and
 - Highway Safety Manual (both network and project-level analysis methods).

Opportunities

- Improved coordination between state data and safety offices.
- More and better data?
- Better GIS and integrated data.
- Shared technology and research.

SAFETY AND MOBILITY

Mobility and Reliability

- Travel time index,
- Planning time index, and
- Average travel rate.

What's New?

- Performance Measures Committee call for papers;
- SHRP II: Project 3-2.2: Establishing National and Local Monitoring Programs for Mobility and Travel Time Reliability; and
- National Transportation Operations Coalition (NTOC) recommended measures.

NTOC FINAL SET OF MEASURES

- Customer satisfaction,
- Extent of congestion,
- Delay—nonrecurring,
- Delay—recurring,
- Incident duration,
- Speed,
- Throughput—person,

- Throughput—vehicle,
- Travel time—link,
- Travel time—reliability, and
- Travel time—trip.

Customer-Oriented Measures: What's New?

Continued emphasis on customer surveys.

Observations and Trends

- Data business plans (California, Florida, Alaska, and Montana).
- Strong IT involvement and technology plans (Michigan, Minnesota, and Idaho).
- No key changes to data systems to accommodate performance measures.
- Linking performance measure areas.
- Data partnering and sharing (Florida).
- Safety and congestion.
- Microsimulation modeling (California and Minnesota).
- Data marts (Washington).
- Tools to incorporate real-time data.

Data Business Plans in Florida

YSELA LLORT

JAMES GOLDEN

Florida Department of Transportation

Florida DOT (FDOT) has developed a management process joining transportation performance measures with a goal-oriented business planning strategy. The FDOT transportation management process is policy driven, supported by data, and systematically evaluates the condition and operation of the state transportation system against goals and objectives

There is a strong linkage between statewide transportation goals and program funding. The Florida Transportation Plan (FTP) identifies long-range goals and policy-level objectives for the entire transportation system. The Short-Range Component (SRC) of the FTP describes in more detail, how FDOT plans to implement the FTP, including measurable objectives for periods of up to 10 years. The department's Program and Resource Plan ensures there is sufficient program funding to achieve the FTP objectives through the SRC. The Program and Resource Plan requires the development of detailed operating policies and establishes funding levels for all state programs. The Program and Resource Plan guides the development of the 5-year work program.

The current 2025 FTP identifies goals and objectives, together with strategies to guide Florida's transportation decisions for the next 20 years. The 2025 goals are

- A safer and more secure transportation system;
- An enriched quality of life and responsible environmental stewardship;
- Adequate, cost-effective maintenance and transportation asset preservation;
- Stronger economy through increased mobility for people and freight; and
- Sustainable transportation investments for Florida's future.

Each of these five broad goals is further refined by specific objectives in the 2025 FTP. The SRC takes each goal and objective and further refines them into specific measurable standards. The department tracks systems performance against those standards over time and performance is assessed.

FDOT has a long history of evaluating the performance of the transportation system through performance measures and, over time, modifying goals and objectives to meet the goals of the department as expressed in the FTP.

Approximately 3 years ago, the department began the process of translating the traditional system performance goals and objectives into management goals and objectives through the development of business plans for every office activity within the department. These business plans serve as a linkage between the goals and objectives of the FTP, the performance measure of the SRC, and the actual operation of the FDOT by its many offices, service units, and employees.

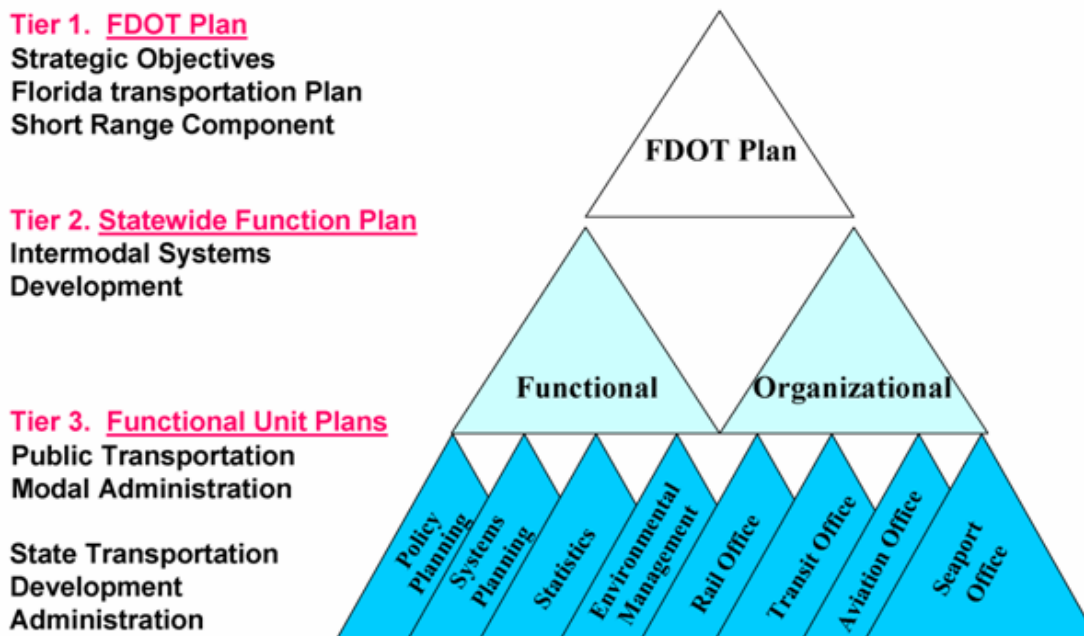


FIGURE 1 Business plan model.

As illustrated in [Figure 1](#), the FDOT Business Plan model is a tiered system. Tier 1 is the statewide planning documents. Tier 2 plans can be one of the two types, either a functional plan or an organizational plan for a major statewide departmental unit. Tier 3 plans focus on individual offices within each functional or organizational element of the department. For example, Figure 1 illustrates intermodal systems development. Intermodal systems is subdivided into two areas: public transportation modal administration and state transportation development administration. Individual offices are organized within each administration and each office is responsible for developing a Tier 3 plan.

Each business plan must address seven criteria areas as appropriate:

- Leadership;
- Strategic planning;
- Customer and market focus;
- Measurement, analysis, and knowledge management;
- Human resource focus;
- Process management; and
- Organizational performance results.

Within each criteria area there are seven elements: objectives, activities, performance indicators, targets, current status, and person responsible. The performance indicators and targets ultimately relate to the PMs in the SRC.

Information and requirements flow down from the Tier 1 plans, while feedback, supported by performance measures (data), flow upwards in the department to Tier 1.

FDOT has historically tracked the performance of the department through 11 metrics. As part of the transportation performance measures–business planning process FDOT has consolidated these 11 metrics into five.

- Transportation systems safety;
- Customer and market focus ;
- Production performance ;
- Transportation system performance; and
- Organizational performance.

The transportation system performance metric is the measure of how well people and goods move within the state. This overall measure contains four specific modal measures of system performance, each with specific measurement elements:

- Highway condition—maintenance rating, bridge rating, pavement condition;
- Highway operation—ITS deployment, person hours of delay, incident compliance, traveler information accuracy, and commercial vehicle incident rate;
- Transit condition—ridership growth; and
- Transit operation—to be determined.

To manage all the data from the FDOT performance measures, the department has developed the Performance Measures Database. This database assembles all performance related data into a single location. All data is accessed through a commercial software product, Panorama Business Views (PBViews)

FDOT faces several challenges in the development of the PM database.

- Communication:
 - Adapting performance reports for various users.
 - Data collection and methodology development require close coordination between data owners and methodology developers.
- Integration of large databases and management systems:
 - Data intricacies in collection and storage can get lost in the generalization of a large database.
 - Keeping the data current and repeatable.
- Consistent data and sources: Blended measures may have data from various sources
- New data needs: FDOT has avoided new data collection efforts as much as possible due to the long start up and testing required

Despite the challenges in the development of the single database, FDOT has successfully integrated the PM and business planning processes.

What Does Senior Management Need to Know About Data for Performance Measures?

RANDY IWASAKI

California Department of Transportation

Introduced by Governor Arnold Schwarzenegger's administration, GoCalifornia provides a vision of effectively managing the transportation system. While new facilities will be built, the biggest improvements in transportation services will come from making the best use of the system that is already in place. However, without a comprehensive understanding of how the system performs, the most effective improvement cannot be identified and the results of these improvements cannot be consistently measured. This is why the foundation of GoCalifornia is monitoring and evaluation based on data.

GOCALIFORNIA

The GoCalifornia initiative requires more than just an evaluation of operational impacts (Figure 1). The integration of land use with transportation and economic issues including return on investment (ROI) and sustainability must be studied. The impact of new freeways lanes on land use and economic development or the impact of new development on transportation services is not clearly understood and neither is the impact of jobs and housing proximity to the transportation system. Economic changes have major impacts on transportation yet data and tools are not available to complete this

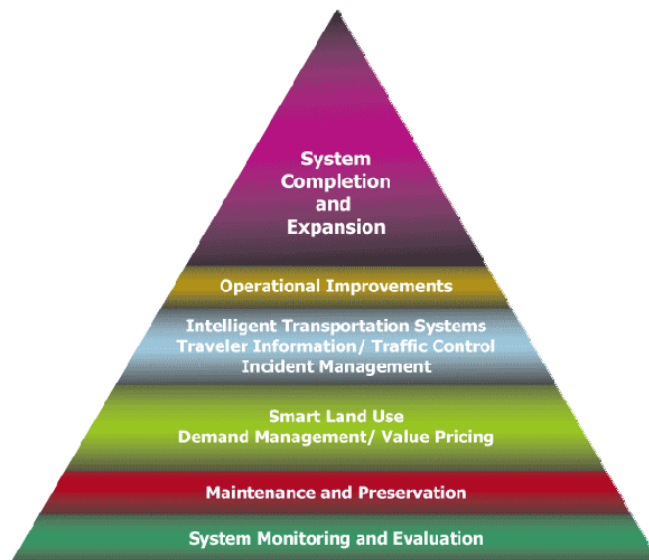


FIGURE 1 Strategies to maximize mobility.

analysis. Without data and the tools to turn that data into information, the vision of GoCalifornia to reduce congestion below today's levels cannot be achieved.

The governor and the legislature recently agreed on a package of bonds that will be submitted to the voters in November. The proposed bonds will fund a variety of important infrastructure improvements—including transportation improvements. If the bonds are approved, transportation improvement projects will be selected based on performance. This is just another example of the need for quality data that will in turn provide very important information for decision making at all levels within state government. Ultimately, we can become more accountable to the public by investing the right dollars in the right places. Performance measures, supported by good, reliable data, will support the decision-making process as well as demonstrate how successful transportation projects have been implemented.

THE PROBLEM

Caltrans, like many state DOTs, has a wide variety of data that is used to make decisions. However, that data is stored in myriad databases that are disjointed and uncoordinated, have data that are of varying usability, and are inconsistent or duplicated in other databases. These silos of information are a waste of resources and reduce the effectiveness of business decisions both in real time and in the longer term.

Multiple sources of information lead to confusion and difficulty determining a reliable source. Inventory information is available in IMMS (Integrated Maintenance Management System), PMS (Pavement Management System), TASAS (Traffic Accident Safety Analysis System), TSN (Transportation System Network—an inventory, safety, and traffic volumes system), SHI (State Highway Inventory—data to support system planning), PMCS (Project Management Control System), and other databases. Data is duplicated in various systems due to the needs of individual divisions. Lane miles in one database may include auxiliary lanes or could include miles maintained that are not state highways or could include proposed relinquishments. This confusion leads to different answers to the same question leading to duplicate work, manually recreating data, and, more importantly, a loss of credibility for the department. Standard (canned) reports do not provide the necessary information and customized reports are difficult and time consuming to develop.

With disparate databases and duplicate information, it is difficult, if not impossible, to make an accurate and timely response. Along with contradicting information in each database, an ability to strategically analyze across different types of assets and transportation services is difficult. Cross-item priorities allowing for the best use of limited funds, such as comparing routine pavement maintenance to maintaining a ramp meter or a loop detector, is not currently possible. Coordination of asset management systems across department silos is a complex problem that has not been fully addressed by the department.

This coordinated information can also be a key component of system performance measures. While safety and pavement measures are well cataloged, other measures are either missing or inconsistent. People movement, on-time performance of transit systems, and sustainability are three areas where new data sources must be found to gauge effectiveness. The increased use of performance measures will drive the need for even more data. Coordinated information can potentially decrease the overall costs to collect and manage data across the department while improving access to quality data.

Besides measuring and reporting on the department's performance, better ways to visually display data is necessary for full public involvement. SAFETEA-LU is asking state DOTs to find better ways to visually display data to improve public participation. FHWA's traveler survey found the public wants to be more involved in transportation planning. Tools to turn data into information are not widely available. Most reporting via visualization tools such as GIS, computer-aided drafting and design (CADD), or modeling tools are developed on an ad-hoc basis.

CONCLUSION

Knowledge is an intangible asset that has incredible value. Beyond having information to make more effective decisions, being able to share data effectively and understand its accuracy and uses will allow us to make our current silos of information transparent. Nimble and dynamic systems leading to quick and accurate information is needed for effective decision making. Data must only be collected once and used many times. Data must be understood and readily shared.

Alaska Department of Transportation and Public Facilities Perspective

JACK STICKEL

Alaska Department of Transportation and Public Facilities

1. How have you used current data collection activities to feed performance measures?

a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

ADOT&PF, like most transportation agencies, is divided into planning, design, and engineering, construction, maintenance, and operations, and commercial vehicle functional areas. ADOT&PF also has marine and aviation functional areas. Further, some functions are statewide (e.g., bridge design), while others are regional (e.g., construction), or both (e.g., regional and statewide). This analysis only considers data collection activities where the planning function (program development division) is a data steward. The data steward role includes the collection, quality control, transformation, documentation, archive, and access of transportation data.

ADOT&PF has identified eight core business areas where planning is a data steward. There are other non-planning data collectors in the department, i.e., measurement standards and commercial vehicle enforcement. However, this analysis only deals with the eight core planning function data business areas. These eight core data business areas are

- Accident reporting;
- Bridge management;
- Maintenance management;
- Pavement management;
- Road weather information system (RWIS);
- Traveler information;
- Traffic; and
- Temperature data probes—weight restriction.

The ADOT&PF planning function has two ongoing programs where the data collection process is tailored to performance measures:

- HSIP and
- Pavement rehabilitation.

Highway Safety Improvement Program

For each accident year, planning provides three accident reports for the regional HSIP managers: accident rate summaries, intersection crash parameters for input into the Intersection Magic software application, and the named intersection accident rate summaries. The first two extracts are standard among state DOTs. The Named Intersection program has been developed specifically for the ADOT&PF HSIP. The Named Intersection program is described further in

Question 3 [Note: the Named Intersection program is being featured at the North American Travel Monitoring Exhibition and Conference (NATMEC) poster session No. 1 this June].

Pavement Rehabilitation

DOT collects pavement profiler data for state-maintained roads and some higher functionally classified MPO roads within the MPO boundaries. The PMS administrator prepares a list of all pavement sections meeting the threshold for immediate repair, rehab expected within 5 years, or no rehabilitation is anticipated within the next 5 years. The international roughness index (IRI), averaged over 1-mi increments, is transferred to the legacy transportation database, where it is combined with other indicators [accidents, annual average daily traffic (AADT)] to prioritize pavement rehabilitations where funding is a factor. However, this process is a manual one at this time.

The State of Alaska has a formal missions and measures program (www.gov.state.ak.us/omb/results/index.php) for departments to set goals, measure progress, and be accountable for getting results that matter. The program will help answer whether government has spent money on services that produced results or created value. Each agency's program explains why the agency exists, defines its major responsibilities, the results to be produced, how the agency will get those results, and how we will know when success has been achieved. In 2003, Governor Murkowski required each department to undergo a critical management review and establish a strategic framework for the agency's missions and measures program (Figure 1).

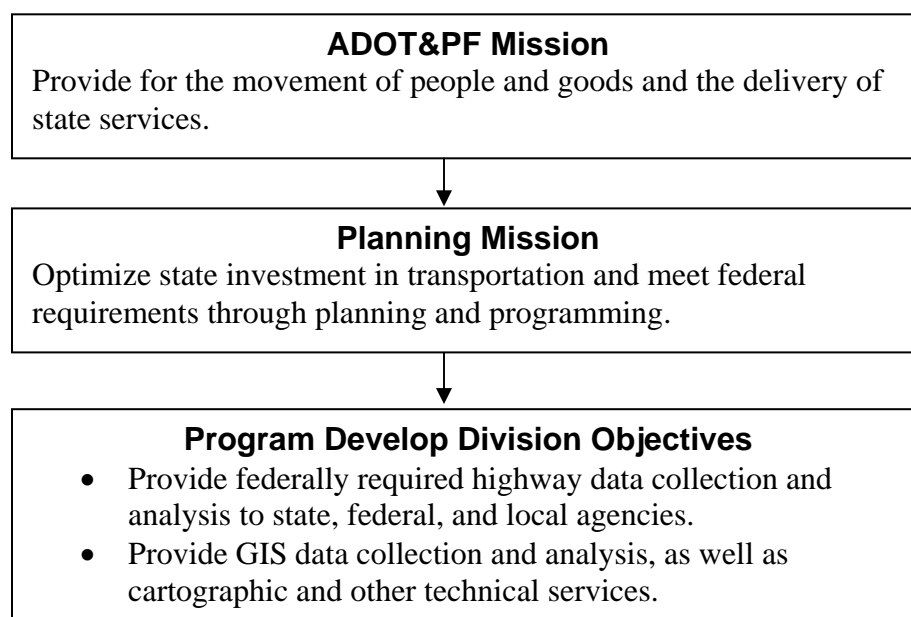


FIGURE 1 The ADOT&PF program.

ADOT&PF missions and measures are tied closely to the ADOT&PF mission, the planning mission, and the program development division (planning function) objectives.

ADOT&PF has participated cautiously in the State of Alaska missions and measures program. Performance measures should be clear and verifiable and would not create a completely new record-keeping activity. The two planning function performance measures are:

Access Optimal Federal Funds for Construction Highway Projects

- **Target:** A federally reviewed STIP not less than 30 days prior to beginning of the federal fiscal year.
- **Measure:** Number of days difference between the target date and STIP transmittal for federal approval

Achieve Measurable Improvement in Highway Safety

- **Target:** A reduction in the number of fatal and major injury accidents of 1% per year over 5 years
- **Measure:** Number of persons with fatal injuries and major injuries using a 3-year average.

The two program development division performance measures turned out being quite general and really do not address the goals of the State of Alaska mission and measures (Note: this is my opinion). Conditions beyond ADOT&PF's control may drive any changes in the performance measures.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

There are no formal data partnerships at this time. There are several indirect ongoing efforts:

1. **Certified Public Road Mileage.** Coordinates the centerline miles on all public roads. This covers the Bureau of Indian Affairs, Indian Nations, Alaska Division of Natural Resources, U.S. Forest Service, National Park Service, U.S. Corps of Engineers, U.S. Coast Guard, U.S. Fish and Wildlife Service, and the two Alaska municipalities (Anchorage and Fairbanks). An online report is available at www.dot.state.ak.us/stwdplng/highwaydata/roadmiles.shtml.

2. **Community Tracking Mileage.** DOT verifies state-maintained roads and local road miles for part of the Department of Commerce, Community, and Economic Development's state revenue sharing program.

3. **Pavement Rehabilitation.** DOT collects profiler data for state-maintained roads and some higher functionally classified MPO roads within the MPO boundaries. DOT provides rehabilitation recommendations to the MPOs based on state performance standards.

4. **Vehicle Crash Data.** DOT provides complete, non-confidential vehicle crash records to other agencies to manage safety programs and establish safety counter-measures. These agencies are:

- Alaska Injury Prevention Center—community safety programs;

- Department of Administration, Division of Motor Vehicles, Driver Services—potential driver medical problems;
 - Department of Health and Social Services, emergency medical services (EMS)—pre-hospital injury information that the Alaska Trauma Registry is unable to provide;
 - Department of Health and Social Services, Injury Prevention—health indicators, particularly in safety features such as seat belt usage and work site injuries;
 - Department of Law—risk management for claims and litigation;
 - ADOT&PF, Alaska Highway Safety Office—safety grants, public outreach and education, enforcement, public health strategies, new technologies, and collaboration with safety organizations and local governments.
 - ADOT&PF, Fatal Accident Reporting System (FARS)—fatal accident statistics and analysis

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)? a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

ADOT&PF is embarking on a multiyear data business plan, which will provide a roadmap of where the eight core planning data programs are, where the programs should be going, and how process can be assessed. The data business plan development is being treated as an intelligent transportation system (ITS) project and uses a systems engineering process (SEP) approach. The SEP demonstrates the entire life cycle of the data programs. All design elements and acceptance tests must be traceable to one or more system requirements and every requirement must be addressed by at least one design element and acceptance test. The broad data business plan objectives are

- Understand the data management program goals;
- Align data management programs with the department's goals and mission; and
- Provide a long-range view of data management programs for future planning.

The concept of operations, which documents the physical infrastructure of existing data programs and how these programs fit into ADOT&PF missions and measures, has been completed (Note: a copy can be provided). In addition to the SEP approach, the eight core planning data business areas are tied to the national ITS architecture market packages and the statewide ITS architecture (Alaska Iways Architecture: www.dot.state.ak.us/iways/index.shtml).

The concept of operations outlines an implementation plan for the remainder of the data business plan.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

The Alaska Iways ITS Architecture focuses on six key ITS elements:

- Commercial vehicle operations;
- Internal operations;
- Multimodal information connection;
- Snow and ice control;
- Traveler communications; and
- Traveler safety and infrastructure security.

Each of these six key ITS elements trace back to quality of life and sustainability. The Alaska Iways ITS Architecture is currently under revision; the updated document will reflect changes in technology, new deployment options, and performance measures. The revision will include a seven-step systems engineering analysis (SEA) for proposed ITS projects; anticipated performance measures are part of the analysis.

Although not a part of the eight core planning data areas, the state transportation improvement plan (STIP) development provides for public comment. Specific construction projects also involve considerable public involvement, including meeting presentations.

The most significant development in examining quality of life and sustainability has been in traveler information. The RWIS and the 511 Travel in the Know data business areas are both targeted toward quality of life and sustainability and trace back to the department's mission to "Provide for the movement of people and goods and the delivery of state services" and the Alaska Iways ITS Architecture user needs and requirement analyses.

The Western Transportation Institute (WTI) is nearing completion on a survey for the traveler information website (<http://511.alaska.gov/>) and the 511 Travel in the Know telephone system. A similar survey for the RWIS program will occur later this year. The 511 and RWIS websites as well as the 511 telephone system allow users to provide comments to ADOT&PF. FHWA manages pooled funds for RWIS [Aurora (<http://www.aurora-program.org/>) and 511 (<http://www.deploy511.org/>) programs].

2c. How do these plans incorporate broader data uses beyond performance measures?

The three major plans [Alaska Iways ITS Architecture, data business plans, and Highway Analysis System (HAS)–GIS Interface] identified the data users and the data stewards as part of the user needs analysis. ADOT&PF developed the concept of operations and the long-range vision for each of these plans from the ensuing user requirements. The system architecture, design, testing, deployment, and the validation follow from these user requirements. This trace back is vital to the success of these plans. For example, the spatial geodatabase design incorporated the maintenance asset management system needs for location referencing, attributes, and condition reporting. The data business plan identifies the work centers, databases, and processes within the maintenance management system (MMS). The video inventory supplements this process. The GIS is part of the ITS regional architecture an enabling technology.

3. How have individual data collection systems been developed or modified to better support performance measures? a. What factors were considered when deciding to invest in data system improvements?

From an enterprise perspective, any investment changes in the eight core data business areas, in addition to the ADOT&PF mission, must consider:

- Allocating funds across work programs and the STIP;
- Measuring changes in the transportation network;
- Generating condition and performance reports for the multimodal transportation network (marine and surface transportation) and department assets;
- Allocating funds to meet federal reporting requirements;
- Planning highway design and safety improvements;
- Managing personnel and assets in department operations;
- Planning and implementing targeted programs for highway safety; and
- Providing information for government, legislative, and public requests.

From a functional manager's perspective, changes in funding, procedures, and data stewardship practices must consider:

- The full range of data stewardship practices;
- Integration with existing or proposed databases;
- STIP projects, including both construction and data driven [weigh-in-motion (WIM), traffic, traveler information, ITS deployment, ITS maintenance and operations, and web services];
- Staff response time to requests (legislative, trade-off analysis, HSIP);
- Alaska Iways ITS Architecture and SEA;
- Database synchronization and stability, especially the road network;
- GIS deployment plans;
- Impact on other major data business areas—particularly MMS, PMS, and bridge management systems (BMS); and
- Data access and user tools.

3b. Who were the key people involved and how was timely consensus reached?

The data business plan concept of operations has started the process for a comprehensive look at planning data support for ADOT&PF-wide performance measures. The next step in the data business plan is the architecture and requirements phase. Everyone agrees there is a need for quality data not only for performance standards but also for the end user. Getting everyone to agree on the process will take time—there are many issues to overcome: institutional, parochial (what I call the “Not Invented Here” syndrome), data stewardship, data stovepipes, technology changes, and evolving department business requirements are just a few. The same business units involved in the concept of operations will be engaged for the remainder of the data business plan:

- Alaska Injury Prevention Center;
- Bicycle–pedestrian: statewide;
- Bridge design: statewide;
- Capital Improvement Program: statewide;

- Design and engineering services: statewide;
- EMS and injury prevention;
- FHWA: Alaska Division;
- GIS mapping: statewide;
- IT: ADOT&PF;
- Maintenance and operations: regional and statewide;
- Maintenance management: statewide;
- Marine highways;
- Measurement standards—commercial vehicle operations;
- Municipality of Anchorage;
- Pavement management;
- Planning: regional and statewide;
- Research and technology transfer;
- Road inventory: statewide;
- Road network services: statewide;
- RWIS;
- Traffic: regional and statewide;
- Traffic engineer: regional and statewide; and
- Traveler information—ITS.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures? a. Have existing tools been modified or new tools been developed?

ADOT&PF has two major ongoing efforts to develop new data analysis tools: the HSIP-related Named Intersection program and the HAS–GIS Interface project. Both of these cover multiple work centers and data business areas.

Named Intersection

The Named Intersection program allows the regional HSIP manager to identify the critical intersections in their region that need further analysis. The distance from the intersection along each road entering the intersection is variable. This allows the exclusion on nonintersection-related vehicle crashes, e.g., an entrance to a business establishment. The intersection also includes other useful information such as speed limits and travel direction. The portion of the route not included in the intersection goes into a named segment report. The AADT is averaged across the links for the intersection and the segment analysis. Online applications provide the named intersection–segment reports; batch reports provide weighted accident rate reports with sorts available for location, accident type, and accident environment. The HSIP manager can adjust the AADT in the weighted accident rate to consider growth patterns.

HAS–GIS Interface

ADOT&PF has embarked on a multiyear project to integrate GIS technology with the mainframe legacy database, the HAS. These targeted upgrade strategies will:

- Improve data access, display, and output;
- Unify the processing, management, and maintenance of the road centerline network and transportation features in an integrated system; and
- Establish a foundation for linear-based GIS within ADOT&PF.

The new HAS–GIS Interface will incorporate the eight core planning data areas either in the spatial geodatabase or through links. Considerable effort went into the User Needs Analysis (June 2003), User Requirements Analysis (September 2003), and Upgrade Alternatives (September 2003) before completing the final HAS–GIS Interface Implementation Plan (December 2003). The long-range vision examined potential broader uses of the data that a modern GIS could provide. The GIS deployment is ongoing; the implementation plan was revisited in early 2006 [HAS–GIS Interface Deployment Analysis: ADOT&PF Geodatabase and Applications Implementation (January 2006)].

The GIS project will leverage two other ongoing ADOT&PF projects: a document management system (DMS) and a roadway inventory program. The DMS is being regionally deployed. The GIS will be linked to this system, where larger documents and other applications will reside. There is one potential side benefit to the DMS. Some users such as right-of-way require more precise location information than the road network-based GIS will provide. These users can locate the project information in the GIS, and then use the DMS for their precise drawings and applications in the DMS.

A road network video log request for proposals is being advertised (may be awarded by the time of the workshop). The video log project will highly leverage the eight core data business areas, particularly maintenance management. The new data source will provide location, attributes, condition, and in some cases, even the existence of assets. Conventional wisdom would suggest this opens the door for potentially many performance measures on asset condition.

4b. How has enterprise tool development incorporated performance measures?

Not yet. This will be an ongoing part of the data business plan development and the HAS–GIS Interface deployment. Certainly, there is a lot of potential as we bring access to a large number of datasets, either within the spatial geodatabase or link to other databases. A modern road network, linear referenced-based GIS, a robust DMS, and a road network video inventory would bring potential to fact-based performance decisions. Along with this potential, there are also challenges:

- Institutional agreement;
- Stovepipe datasets;
- Reporting (who, when, how much); and
- Measurements—realistic, verifiable, achievable, meaningful.

California Department of Transportation Perspective

ROBERT COPP
RANDY IWASAKI
DEBBIE MAH

California Department of Transportation

1. How have you used current data collection activities to feed performance measures?

a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Individual divisions have databases that collect information specific to their divisions or programs, e.g., pavement condition by the Division of Maintenance and safety and travel time information by the Division of Traffic Operations. Only limited data is provided from outside that division. While that is changing, most performance measures are developed within the division supporting their respective performance measures and are not developed as part of an overall data collection program. Efforts are being made to improve consistency and quality of data collected for performance measures. Specific measures from these division databases are now reported for statewide performance measures. Integrating data across the department is being discussed. However, no strategic plan for departmentwide data collection has been developed.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

In developing a set of system performance measures for statewide use, the department formed task force teams with its transportation partners. It was important to include our transportation partners to ensure consensus was reached with respect to the set of measures that could be used on a statewide basis (for consistency and uniformity) and to identify all available data sources that can be shared. Partners included both public- and private-sector interests. Public agencies included MPOs, regional agencies, and local agencies. FHWA and California Transportation Commission staff also participated. As measures were developed, data sources were also identified. Sources included Caltrans, regional agencies–MPOs, local agencies, and others.

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)? a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

A data business plan is being developed to identify data issues including the use, format, and timeliness of the data, duplicate collection, and quality. This is being completed in parallel with developing a departmentwide data model for inventory data as well as a plan for an integrated asset management system. A geospatial data committee will develop a plan to integrate CADD and GIS. The major hurdle to this integration is data. These plans will be shared with a new Business Process Management Committee. This group will prioritize the improvements and

make recommendations to the department's IT management committee. This committee is comprised of deputy directors, district directors and is led by the chief deputy director.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

These types of measures, and the data required, are still under review and development. Because they are complex, as noted, we have deferred their use until additional research can be done with regard to these measures. Caltrans will continue to work with its transportation partners to develop them further.

2c. How do these plans incorporate broader data uses beyond performance measures?

The data business plan will ensure that data is available for performance measures. However, the plan is being developed to discuss data integration issues as it relates to decision support. This will lead to an integrated asset management system that will support cross program prioritization.

3. How have individual data collection systems been developed or modified to better support performance measures? a. What factors were considered when deciding to invest in data system improvements?

Early reports uncovered inconsistencies in data. Some data resided in many databases and it was difficult to determine the best source. Additionally, to get the data for reporting is a tedious manual process. Some processes are well defined within divisions. Others are not and improvements need to be investigated further. How that data is shared needs improvements. Some data is maintained by more than one division or program. Although data is collected by the divisions—programs, the data is not readily available by all. All of these factors have led to the idea for a data business plan. It has also prompted the agency secretary to evaluate the viability of an agencywide data warehouse and reporting system.

3b. Who were the key people involved and how was timely consensus reached?

We have not yet reached consensus on how to improve data collection systems to support performance measures. We are testing the viability of using a BI software application for a central repository—data warehouse and for reporting and analysis. We are currently developing a proof-of-concept project sponsored by the agency secretary.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures? a. Have existing tools been modified or new tools been developed?

Performance measures development has not driven the development of GIS or modeling tools. However, it is imperative these tools be in place to present performance measures effectively. A web-based GIS architecture with dynamic segmentation capability has been developed to take any department data with post mile location information and integrate them with other data. This capability is being completed in conjunction with the development of a statewide traveler

information website. This site will provide the architecture to integrate all data that is presented to the public. The same architecture can be used on the intranet for internal data sharing.

Microsimulation modeling will take performance data and begin to identify bottlenecks, appropriate use of ITS tools, and even estimate future performance under different scenarios. These models and other simpler visualization tools will be extremely valuable in sharing the outcomes of performance measures with the public, stakeholders, and decision makers. A strategic plan is being developed for all transportation modeling in California. One of the first phases has been the completion of a strategic action plan to improve microsimulation modeling.

4b. How has enterprise tool development incorporated performance measures?

See the previous answer.

Florida Department of Transportation Perspective

JAMES GOLDEN

YSELA LLORT

Florida Department of Transportation

1. How have you used current data collection activities to feed performance measures?

In most cases, data from our regular data-collection activities have been used to support performance measures. FDOT internal databases reflect most program activities. However, some areas require additional data collection development or collaboration with outside agencies. Performance measures selection and data availability are closely related.

1a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Data for FDOT internal key performance measures are automated in a new performance measures database. They are drawn primarily from our legacy systems which mean little new input has been necessary to meet our data needs. However, as new measures are developed or existing measures mature, some new data input may be required. Performance measures owners work with the data managers to provide support data in the needed timeframe and format.

In addition, any new data requirement is added to department procedures, handbooks, and manuals so that it becomes part of the standard data collection program.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

On a statewide basis, not much has happened in this area to this point. There may be some opportunities in the future. Our districts are looking for new ways to share data with other local agencies and entities. Consistency of data is an issue, metadata will be vital, if we are to understand data from others and ensure we use it correctly.

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)?

We handle improvements to data systems for performance measures the same as for any other purpose. Our business plan guides us to constantly look for opportunities for improvement and efficiency through the use of new technologies and streamlined processes.

2a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

Our data collection processes for transportation system measures are documented so users can understand the appropriate uses and limitations of the data. Our business plan has a customer

focus and guides us to listen to customer feedback to help us identify ways to improve data quality.

We have been working on the implementation of a full-performance measures database system for over 3 years. Our efforts have been to assure a user-friendly interface and effective presentation of measures. There has been a series of iterative steps to improve and prioritize data within the system even before first publication. In addition, our DOT business plan process (a tiered business-action plan system) is helping employees at all levels to understand and be directly involved in the collection, analysis, and use of organizational performance measures.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

This area of performance measure development has presented several challenges. Quality of life (as related to transportation) is difficult to quantify, has little FDOT-maintained data available, and requires collaboration with other agencies and entities. Several attempts have been made in the past to measure the transportation system's impact on quality of life. Several support measures were developed but progress is slow in the development of higher level outcome measures.

The FDOT internal business plan has a strategic objective directed at improving employee well being which addresses the issues of quality of life and sustainability. A team has been organized to analyze existing programs and recommend new ones.

2c. How do these plans incorporate broader data uses beyond performance measures?

The FDOT business plan and performance database system puts data in the hands of all managers and employees both for information and for review and analysis. The FDOT business plan stresses fact-based decision making. When fully implemented, the plan will directly link every employee to his or her unit, division, district, and the statewide strategic plans giving them the clear understanding of not only the how of their work and effectiveness but the equally important dimension of why their work is important to their success and organizational success.

3. How have individual data collection systems been developed or modified to better support performance measures? a. What factors were considered when deciding to invest in data system improvements?

Data accessibility is key to performance measures development. Performance measures are often developed by people and offices that are not part the information systems office. The more accessible the data is to managers and planners, the more opportunities there are to develop system and organization performance measures.

Two primary systems have been introduced or created at FDOT. First, we have developed an Enterprise Information Portal for the agency to provide a central clearinghouse of data and put it at the fingertips of every employee. Second, we selected and are implementing our performance measures software. We reviewed 11 vendor products in the selection of this program with a focus on ease of use, accessibility, and clarity of data-information while being able to integrate with our legacy systems.

3b. Who were the key people involved and how was timely consensus reached?

Senior management and program office collaboration were the key players in the selection and development of the performance measures database system. Measure owners have worked with our performance management office to design an effective layout and presentation of measures. Each measure is reviewed and approved by the FDOT executive board prior to publication. A performance measures steering committee, in cooperation with the measure owners, oversees the display and presents proposed measures to the executive board for approval and publication.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures? a. Have existing tools been modified or new tools been developed?

There is continuing interest in improving GIS capability for transportation data. FDOT currently utilizes ArcView and ArcGIS software. This software is primarily used for reporting purposes for displaying geographic data on a regional, district, or county level. An effort is underway to utilize GIS information for land use mapping.

4b. How has enterprise tool development incorporated performance measures?

Primary interest in GIS tools and software are in the displaying and reporting of transportation-related data. Performance measure data analysis could identify areas in the state where performance improvements are needed.

Idaho Transportation Department Perspective

DAVID EKERN

GARY SANDERSON

Idaho Department of Transportation

1. How have you used current data collection activities to feed performance measures?

We do most of our data collection in house. Field crews collect data about the condition of transportation assets for which we have performance measures: bridge heights, widths, and weight ratings; pavement roughness, cracking, rutting, skid; crash reports on and off our state highway system; urban travel times; rural congestion conditions; railroad crossings; seat belt usage; rest areas; etc.

1a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Data collectors know the quality and quantity of data needed to feed the performance measures. They know why they are collecting the data and how it will be used. The performance measure results are communicated to the data collectors so they know the effect of their efforts.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

We enjoy a successful partnership with the Boise-area Transportation Management Area (TMA) for the collection of urban travel time data. Both parties supply personnel and share the results for their congestion management systems. We receive crash reports from local agencies to populate our crash analysis reporting system. We review railroad crossings and other high-accident locations in partnership with local agencies, rail companies, EMS providers, and safety organizations.

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)?

Our technology investment plan requires all major improvements to any technology to be planned, reviewed, approved, and coordinated. The resources needed (consultants, our own staff, hardware, software) are estimated and prioritized according to management's information strategy plan.

2a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

The data improvement plans detail how the data will be collected, analyzed and incorporated into the department's data systems. They detail how the data is stored, accessed, and used most appropriately.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

All performance measures should influence the travelers' experience, but perhaps our best example of assisting quality of life would be our urban travel time data. The ability to get to a destination when planned is a direct contribution to quality of life. The travel time data can help travelers plan departure times, especially on unfamiliar routes.

2c. How do these plans incorporate broader data uses beyond performance measures?

We have much data beyond what we require for performance measures. Some is used for scheduling maintenance, developing highway construction projects, purchasing right of way, designing traffic signal systems, etc., and many tasks in maintenance and operation of the transportation system.

3. How have individual data collection systems been developed or modified to better support performance measures?

As new performance measures are adopted, data collection systems are developed or modified to provide the needed information. We routinely examine our data collection processes to evaluate if improvements are needed. One example would be using roadway widening feasibility as input to where rural passing lanes should be constructed.

3a. What factors were considered when deciding to invest in data system improvements?

Our information strategy plan helps us prioritize which IT investments are most critical. Factors we consider are cost, ease of implementation, time schedules, adherence to our IT goals, coordination with the department's data systems, and, of course, political urgency.

3b. Who were the key people involved and how was timely consensus reached?

Top management support for the information strategy plan and the technology investment plan has been achieved. We also seek support from mid-managers though some of them are uncomfortable with changes to the status quo. We have not yet achieved full timely consensus. Management could autocratically dictate IT practices, but we prefer to more slowly achieve consensus through discussion and encouragement.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures?

We have decentralized our GIS Shop, pushing it out to the masses, encouraging all groups to take advantage of this useful tool for their own analysis and display of performance measures.

4a. Have existing tools been modified or new tools been developed?

Existing GIS tools have been modified, in that they are being used by more people and for a wider array of applications.

4b. How has enterprise tool development incorporated performance measures?

We obtain tools (hardware, software, knowledge) to support the performance measures detailed in our strategic plan.

Kansas Department of Transportation Perspective

JULIE LORENZ

Kansas Department of Transportation

Kansas DOT (KDOT) initiated the performance measures process more than a year ago and has used a very inclusive process to develop draft measures. We are currently presenting draft measures to the review board (made up of the executive staff) for adoption in a year or so and we are in the process of presenting them to senior management for adoption. Measures are being developed in each of six strategic areas including: pavement preservation and maintenance; safety, program, and project delivery; economic impact; system modernization; and workforce priorities.

To date, we have used existing data and programs for the measures. The data may have, in some areas, been generated in a different format, but it already existed in the system.

Data used to date in the newly defined performance measures include

- Pavement condition measured annually;
- Bridge health index measured every 2 years
- Overall maintenance condition of the system reported annually;
- Fatalities on the state highway system reported annually;
- Injuries reported annually, seat belt usage reported annually;
- Various reports on program and project delivery and related performance (including customer satisfaction) reported monthly;
- Capacity or safety improvements to the system reported annually;
- Workforce-related information to be reported on periodic basis; and
- We are just beginning work with FHWA on measuring freight movement through Kansas.

The questions could not be addressed at this time, as the development of KDOT's performance measures has not yet reached this point. We have generated data from existing sources thus far with the understanding that current programs and methods of data management and collection will need improvements as these measures are further developed.

Maryland Department of Transportation Perspective

AAIRON FRANKLIN

Maryland Department of Transportation

1. How have you used current data collection activities to feed performance measures?

a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

In many cases, the data collectors collect data to support their everyday operational decision-making processes. The data also supports our overall performance management program. In those instances, the data collectors are not affected by our program. We take their data, perform the necessary calculations, and report that data to management through the organization.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

The state partnered with local governments and MPOs that collect data more efficiently than we can. In many instances, that data pertains to specific survey research or local police data.

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)? a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

We have made a conscious effort to continuously improve our data-collection processes and reliability of data. We have developed data profiles to assist data collectors to document factors such as collection processes, data controls, calculation methods, operational definitions, etc.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

It has been a major challenge to convince senior leaders that we can scientifically measure those factors. In light of that, we have few measures in this area outside of measures benchmarked from other agencies.

2c. How do these plans incorporate broader data uses beyond performance measures?

We are actively working to implement a web-based BI system that would allow for quick access to data. This would enable broader use of data outside of our performance measures.

3. How have individual data collection systems been developed or modified to better support performance measures?

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures?

Within our agency, little effort has been made in improving data-collection systems including methods—tools for displaying or interpreting data. On a higher level, various agencies from within the state have made significant progress in the area. This has created considerable interest among other agencies to implement similar systems. We are currently pursuing GIS and BI applications.

Metropolitan Transportation Commission Perspective *San Francisco Bay Area*

LISA KLEIN

Metropolitan Transportation Commission, San Francisco Bay Area

1. How have you used current data collection activities to feed performance measures?

a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Much of the data for the system performance monitoring comes from the owner–operators of the system, and this will likely be the case for the foreseeable future for most data. In the limited cases where the Metropolitan Transportation Commission (MTC) does collect data (e.g., real-time traveler information), there tends to be disconnect between data collection and planning applications of system performance measures. The challenge is that folks are so focused on getting the system up and running that little attention has been given to how to make the data useful for other applications.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

Active partnerships have been limited as we continue to rely on data that is already being collected. With tight operating budgets, it is difficult to ask agencies to collect additional data and much of the data already collected is required for state or federal reporting; making any changes difficult.

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)?

We do not have any such plans.

3. How have individual data collection systems been developed or modified to better support performance measures?

No modifications have been made to date. We may eventually make some modifications to the way real-time traveler information data is archived, but we are not there yet.

MTC has provided some comments to the California Highway Patrol (CHP) on minor changes to incident reporting forms that may help us better track factors affecting collisions involving cyclists and pedestrians. But this is in the preliminary stages only and I do not know the ramifications for the data systems involved.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures? a. Have existing tools been modified or new tools been developed?

We have done limited work to use GIS to display freeway congestion data. This is an area we could do much more in.

4b. How has enterprise tool development incorporated performance measures?

Not applicable.

Minnesota Department of Transportation Perspective

RANDALL HALVORSON

JONETTE KREIDEWEIS

MARK LARSON

Minnesota Department of Transportation

1. How have you used current data collection activities to feed performance measures?

Many key department measures have been developed from existing legacy systems, such as: Transportation Information System (TIS), PONTIS, PMS, Construction Management System, Work Management System, Program and Project Management System (PPMS), and Regional Transportation Management Center (RTMC) archived data. Specialty offices are stewards of the data and process it into regular periodic measures reports—annually, quarterly, or monthly.

1a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

For department-level measures, functional offices take the lead in developing the capacity and systems to collect and process data and report measures. They often have taken the lead in recommending the measures.

The Office of Transportation Data Analysis (OTDA) is working to identify ways to expand the utility of current data collection programs. Examples include:

- Setting up a new structure in TIS so that data can be sorted and reported for designated Interregional Corridors (IRCs). Performance data on IRCs is critical for investment decisions.
- Developing an enhanced methodology to provide districts and other partners with electronic access (via TIS) to data on 25-year and 30-year traffic projections. These data are being used as input assumptions to drive analysis of longer term safety needs and pavement measures.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

Systematic cooperation is held back by the limited use of PM systems in local governments, except for some larger cities and counties. There is cooperation on some specific data collection systems:

- Minnesota DOT just began a program to assist the 87 counties in collection of pavement performance data in parallel to its performance data on trunk highways. Minnesota DOT's State Aid Division purchased a new van for data collection. Minnesota DOT's Materials Office will test one-fourth of County State Aid Roads each year, and analyze and disseminate the data to counties.

- Minnesota DOT has legal responsibility for collecting and maintaining bridge condition data. It certifies local governments to do inspections and delegates the collection of data to them. The inspection data is maintained in the state's PONTIS system. They could access the data to generate performance measures data, but few have done so.

- Performance measures have been integrated into the planning process for Minnesota DOT's eight districts. While there is not integrated data collection or measures with local entities, the state measures have become factors for Area Transportation Partnerships (ATPs) as they prioritize projects for the STIP. ATPs include county, city, tribal, Regional Development Commission (RDC), MPO, transit, and other partners. Much more needs to be done to build their understanding and acceptance of the state performance-based planning framework.

- Minnesota DOT's OTDA is working with tribal governments to improve data on the existence-mileage of Indian Reservation Roads. Once we know where they are, we can start working with tribes to collect performance data on crashes, traffic, and other measures-indicators.

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)?

Minnesota DOT does not have a data business plan, but the importance of measurement applications is recognized as IT projects are prioritized quarterly by top staff. All new IT investments must demonstrate how they support department strategic directions and support improved performance towards goals.

Minnesota DOT has what is called a Stage-Gate Model Project Process for IT projects. All projects that cost more than \$50,000 must go through a project review and prioritization process. Criteria for ranking projects include value which goes back to strategic match and how the investment will improve performance. Please see [Figures 1 and 2](#).

2a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

There is no formal comprehensive plan for data quality assurance. Lead responsibility lies with stewards of data in functional offices. They are responsible for understanding and communicating the limits of data.

The Office of Investment Management (planning and measurement) plays a general role in guiding and assessing which measures and data sources are used for decisions at the department level.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

Minnesota DOT has few measures of this type, choosing to focus mainly on measures that are significantly under agency control or influence. For several environmental indicators in the Statewide Transportation Plan, such as "Acres of undeveloped land converted to another land use," data is obtained from existing sources at partner state and regional agencies, in this case, the regional Metropolitan Council. Others are the Minnesota Department of Natural Resources and the Pollution Control Agency.

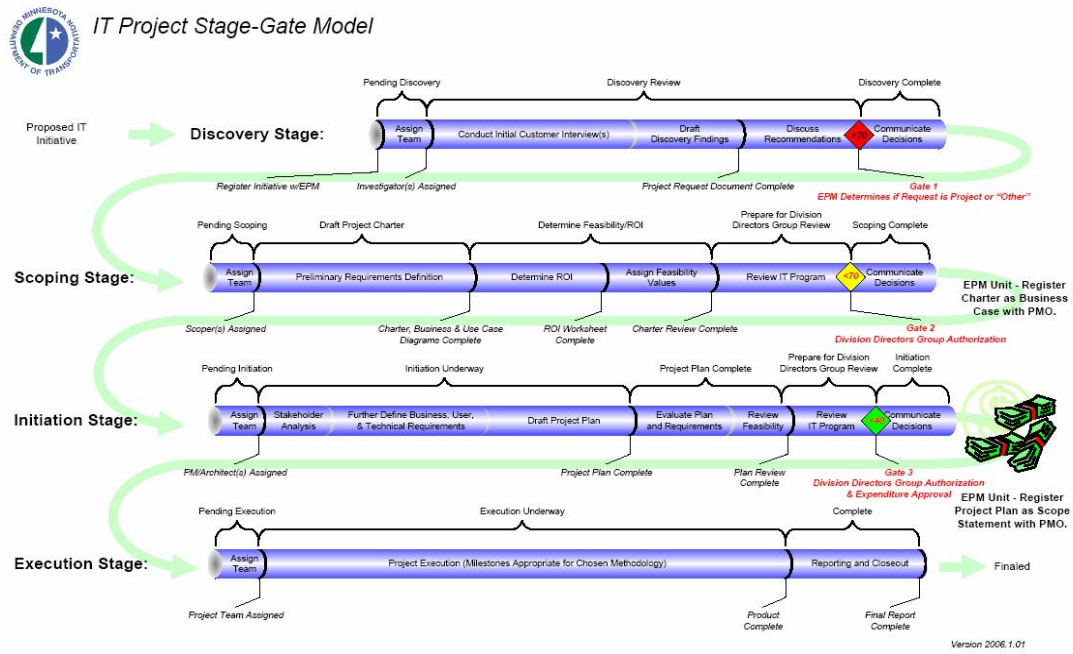


FIGURE 1 Minnesota DOT Project Stage-Gate Model.

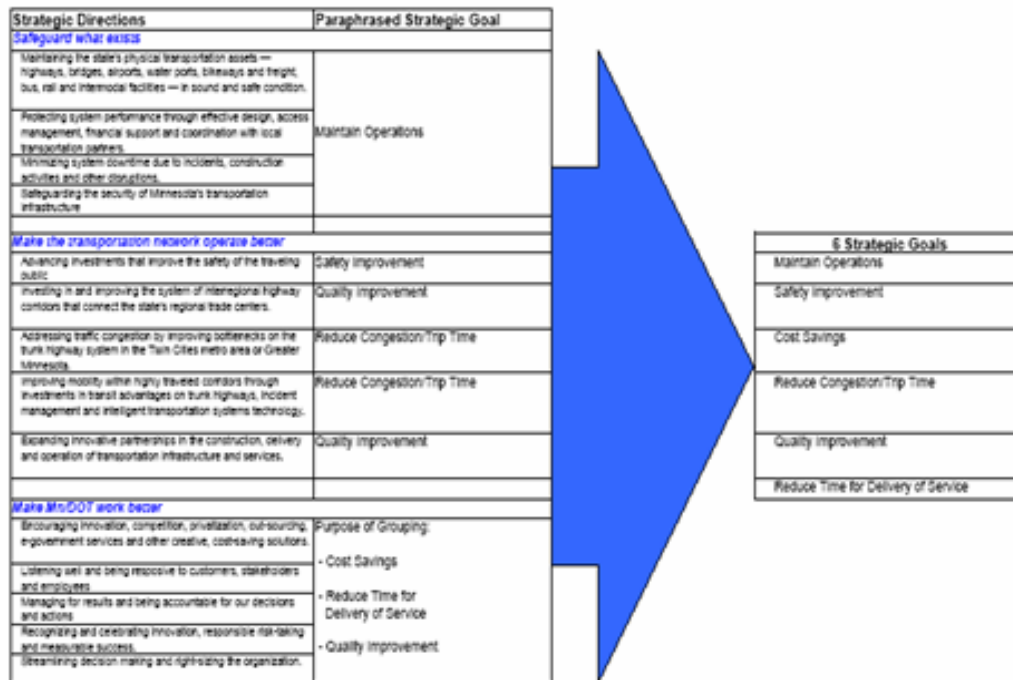


FIGURE 2 Minnesota DOT projects selection process: strategic value criteria.

Extensive customer satisfaction measures are fed by market research designed and coordinated by Minnesota DOT market research staff using contracted professional market research firms.

Measures of Access to Transportation are being explored for future consideration in a research project at the University of Minnesota.

2c. How do these plans incorporate broader data uses beyond performance measures?

Not applicable.

3. How have individual data collection systems been developed or modified to better support performance measures?

Often data management systems themselves (pavement management, PPMS) have not had to be greatly modified, but the frequency and timing of data collection or processing has been modified to fit measures reporting schedules, or new processing algorithms have been created to produce new types of measures from the data. Management reporting schedules are set centrally. While many measures were created in functional areas, some were solicited centrally by management or via the statewide transportation plan. Examples include:

Pavement

Pavement condition data collection has been increased to annually from alternate years. Formulas were developed for a new statewide transportation plan measure of pavement remaining service life.

Program and Project Management System

Fields have been added to PPMS to get better data for measures reports on project delivery timeliness and reasons for delay, but major system changes were not required. Additional fields will be added to PPMS to identify which statewide transportation plan policies and outcomes each project contributes to. This will allow Minnesota DOT to roll up investments by policy in a new more accurate way.

Transportation Information System

An ongoing major project is building a new TIS. The new TIS will provide a stable linear datum for all public roads in the state and synchronize TIS attribute data with the department's GIS base map. This will allow us to map TIS performance data (like crashes) to all systems. Our long-term vision includes making this data easier to use (on desktop PC versus mainframe) and much more accessible via the web to internal and external partners. We are also working to design the new system so that it can provide data on historical as well as future conditions.

Work Management System

In the maintenance area, the existing work management system (WMS) has been used to collect and report and process data from plow drivers on snow and ice removal time and material usage. Drivers input data after completing routes. For the future, Minnesota DOT is testing automated data collection at the point of delivery using AVL systems with GIS.

Sign System

A large new sign management system project on the horizon will support greatly improved measurement of system sign condition (retroreflectivity). This proposal was delayed in the past due to questions about the payoff of detailed data collection for a relatively low-value asset.

Modeling and Prediction of Performance

We would like to improve predictive capabilities in all areas. This has proven difficult in Minnesota and nationally with PONTIS, the BMS.

3a. What factors were considered when deciding to invest in data system improvements?

See criteria included in the earlier-mentioned IT Stage–Gate Process. Other factors to consider include:

- Needs and priorities for the data;
- Other potential sources for obtaining the data;
- Costs and resource availability; and
- How adding additional work impacts existing production activities.

3b. Who were the key people involved and how was timely consensus reached?

General case:

- Data and business area stewards;
- Functional groups involving district and functional office representatives (e.g. maintenance engineers, pavement engineers, design engineers); and
- Management team (six division directors, who are part of executive staff, make final decisions on larger IT projects).

A number of years ago Minnesota DOT's Bridge Office sought changes in the national PONTIS system to facilitate tabulation of bridge data by deck area rather than by bridge, but the change was not supported by the AASHTO PONTIS user's group, so Minnesota DOT's Bridge Office financed and developed the change on its own using a consultant.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures?

Mapping Results

Performance results are displayed on maps for these measures: high crash-cost locations, interregional corridor travel speed, metro area freeway congestion, metro area arterial signal congestion, snow and ice removal, and pavement condition. Location data is currently in TIS and GIS, and will be merged into a new Location Data Manager (LDM) system.

GIS

GIS is becoming an increasingly important tool for displaying performance data for spatial analysis. GIS and relational databases such as Oracle are also allowing us to do richer multivariate analysis. In an era where resources are tight, we want to make sure we are targeting investments to highest priorities. With multivariate analysis tools, we can overlay multiple data layers to pinpoint areas where there are cumulative performance issues (high crashes, bad pavement, congestion).

GIS is also being used in operations planning to do snow plow routing and to manage maintenance assets such as signs, edge drains, etc. These uses are strengthening our abilities to meet performance goals.

GIS: Snow and Ice

GIS is being used in maintenance operations to provide post-storm data on how long it takes to regain bare pavement after a snow event. These maps post the hours by road segment (880 segments or plow routes) and are posted in truck stations. They visually report performance or event. In addition, an advanced visual weather forecasting system supports snow and ice maintenance operations with hourly updates on pavement conditions, wind velocities, and other detailed weather tracking that assists supervisors with how and when to deploy resources for efficiencies and shortening the length of time to bare pavement and or preventing the loss of bare pavement. (Minnesota DOT has five service levels or performance targets for the type of roadway and level of traffic statewide that it tracks and reports on by event, monthly, quarterly and yearly).

GIS is also being used to track features such as wetlands to address environmental and project development performance measures.

ARC IMS

We are also building new ARC IMS tools for integrating, displaying and providing web access to data, such as the roadway network (new interactive base map), traffic and other factors. Over time, the ARC IMS application can be expanded to include specific performance measure data layers. The ARC IMS application can be viewed at www.dot.state.mn.us/maps/gisweb/.

Microsimulation Models

Microsimulation models are being used and analyzed by Metro and RTMC staff. At some point, they may provide an alternative source for travel time and reliability data.

4a. Have existing tools been modified or new tools been developed?

Both.

- For snow and ice measures reporting, data from various management systems is interfaced with GIS to portray operational performance.
- Automated dashboards were developed using Excel and have been applied to numerous measures reports.
- Snapshots of performance by district were developed using Excel spreadsheets and colored icons (green, yellow, red).

4b. How has enterprise tool development incorporated performance measures?

Minnesota DOT acquired and deployed on a pilot basis a BI performance reporting software for the statewide transportation plan data and for snow and ice operations. This software, in addition to streamlining performance reporting, can provide more analytics and departmentwide access to performance. It also could map the measures structure by policy from the most basic operations level to the strategic level.

The commercial software used has had many limitations in adapting to Minnesota DOT's more complex and extensive measures. The chief example is snow and ice removal measures, which cascade many levels from route to truck station to subdistrict to district to state, with up to five different AADT classes.

Missouri Department of Transportation Perspective

MARA CAMPBELL

Missouri Department of Transportation

1. How have you used current data collection activities to feed performance measures?

a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Our organization compiles a quarterly PM report, Tracker. The data requirements for each performance measure are defined in a document called a detail sheet.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

Several of our safety-related measurement data collectors partner with our state law enforcement agencies and share access to database systems for counts and rates for fatalities and injuries. Other data collectors partner with state and federal program administrators to validate or find benchmarks for their data (e.g., FHWA studies that have state-by-state comparisons help to benchmark which state is doing the best at truck tTravel times).

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)? a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

As mentioned above, the detail sheets are provided for each measure. These are updated semi-annually and posted on an internal website to help users understand the background for each measure.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

These measures have not been developed.

2c. How do these plans incorporate broader data uses beyond performance measures?

They do not.

3. How have individual data collection systems been developed or modified to better support performance measures? a. What factors were considered when deciding to invest in data system improvements?

I do not believe any new data collection systems have been developed. Some databases have been modified to better support performance measures by adding a field here or there to collect specific information or to clarify the information we want to collect in the field.

3b. Who were the key people involved and how was timely consensus reached?

The measurement driver worked with their data collection team to build consensus on changes prior to the deadlines established for publishing the Tracker.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures? a. Have existing tools been modified or new tools been developed?

Not that we are aware of.

4b. How has enterprise tool development incorporated performance measures?

We are not involved in that area of the business, but it would be done in the same mode as mentioned in the second bullet of Question 3.

Montana Department of Transportation Perspective

SANDRA STRAEHL

BILL CLOUD

Montana Department of Transportation

1. How have you used current data collection activities to feed performance measures?

a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Montana DOT's asset management system (known as the Performance Programming Process or P3) is driven by the prediction of performance as a function of funding commitments over time. Funding is allocated to districts, systems, and types of work based on these predictions. The analytic tools used to make the predictions are the department's management systems. Exactly the same data used for P3 is the data collected and used in the management systems. This includes all the normal data collected for pavement, bridge, congestion, and safety management systems.

This will be extended into the reactive maintenance realm in the department's planned update to its MMS. The same pavement data will be used in this updated system that is used in the PMS. In short, the data collection done to feed the management systems is entirely equivalent to the data used for performance measures used in P3, which is used to allocate about 70% of the department's capital program.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

The three MPOs in Montana have traffic count programs that are supported with federal planning allocations. This data is used by Montana DOT and the local governments. Montana DOT is working with FHWA and Indian Health Services in a pilot program that equips and trains tribal members to collect and report highway crash data within reservations. Crash data within reservations has been challenging to acquire. This can be attributable to several factors including sovereignty concerns of tribal councils, the desire to protect tribal members, and inconsistency between tribal enforcement and laws.

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)?

2a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

Montana DOT has, or soon will embark on several key data management-related issues. They include the Infrastructure Data Inventory and Needs Assessment, the GIS strategic plan, and the Road Log LRS Reevaluation Assessment. These plans and assessments are particularly valuable in that they reveal unmet data needs as well as data that is collected but not needed. By evaluating the data in detail, investigating its uses, shortfalls, and potentials, these studies reveal

many things including the importance of the quality of the data, developing quality control measures, securing data quality statements (certification), accountability, the importance of knowing what the data is (metadata), and the overwhelming importance of developing and maintaining enterprisewide enforceable data standards. As Montana DOT continues its quest for better understanding its data, it becomes more and more widely accepted that data business plans are a critical component of the data management environment within the DOT.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

There are, of course, performance measures related to air quality. The one we use is simply no exceedences. We have great flexibility in Congestion Mitigation and Air Quality (CMAQ) since Montana is a minimum apportionment state and we have been using this flexibility to proactively get ahead of air quality issues for years. We use it to address at-risk areas for PM₁₀ (particulate matter less than 10 microns) by buying sweepers and flushers for local governments, and do signal synchronization and intersection improvements at locations with carbon monoxide (CO) at-risk status.

As to quality of life or sustainability, we do not have any explicit measures.

2c. How do these plans incorporate broader data uses beyond performance measures?

These plans have, or will go far beyond meeting the data demands for PM purposes. In fact, these plans begin with the very basics at the enterprise level of understanding why, how, and where it is used. PM, while one of the more critical program development functions at Montana DOT, is only one of hundreds of program areas. Montana DOT has been quite successful in interfacing its data sources, but the real challenge is to develop a truly integrated data system without disrupting the day-to-day activities of data flow and usage.

3. How have individual data collection systems been developed or modified to better support performance measures? a. What factors were considered when deciding to invest in data system improvements?

The MMS update is being specifically designed to support an asset management approach. This is largely because the P3 process has demonstrated the value of data-driven decisions as the system has shown continual improvement using this approach over the last 5 years. Historically, the MMS was used to gather data on time and materials of maintenance activities. To move it towards a truly data-driven asset management tool, additional data will be needed on such things as culverts, light standards, signs, and guard rails.

3b. Who were the key people involved and how was timely consensus reached?

As in any business process change, there has to be a champion, which was the leadership from the maintenance division for the MMS update. But in this case the groundwork had been done years earlier in establishing a performance-based capital program allocation process in P3. At this time within the organization, any facility-oriented data collection or system improvement will be oriented toward performance tracking as consistent with an asset management approach.

The internal process for decision making at the Montana DOT includes an IT governance board that needs to approve all data acquisition or IT system changes. This board actually approved the action.

Montana DOT has also recently completed a Traffic Records Strategic Plan. This plan focuses on data integration to be able to assess, track, predict, and better enforce. I believe the whole area of integration of data for performance needs to receive focus. As an example related to safety, if a state is trying to reduce impaired driving but the court systems across county lines do not share data on DUI (driving under the influence) convictions, this will not be possible. Integration is also essential because no agency has sufficient resources to acquire and manage all the data it needs to make decisions.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures? a. Have existing tools been modified or new tools been developed?

Montana DOT has embraced the ARCGIS line of products for its GIS activities and has done respectably well in keeping pace with the latest advancements in technology. The value of GIS is well understood by many Montana DOT work units and its use is becoming more prevalent every day. However, Montana DOT lacks a coordinated long-range vision for GIS that has support from top management. An increasing number of work units are branching off in disparate directions making it increasingly difficult to manage GIS activities within the department. As such, Montana DOT has engaged with a consultant to develop a GIS strategic plan. The plan will ultimately result in a coordinated approach to GIS development including a commitment to GIS and a long-term focus on vision and direction.

4b. How has enterprise tool development incorporated performance measures?

Any data collected can be portrayed in the ARCGIS environment.

San Diego Association of Governments Perspective

JACK BODA

ALEX ESTRELLA

San Diego Association of Governments

1. How have you used current data collection activities to feed performance measures?

a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Aside from transportation system performance measures, SANDAG collects a variety of other indicators to monitor our economic competitiveness, the region's quality of life, and objectives contained in our regional comprehensive plan (RCP) dealing with issues such as housing, energy, and the environment. Together we collect and maintain roughly 150 different indicators not only pertaining to the San Diego region, but for 25 comparable metropolitan areas as well.

To help manage this information, we just completed the initial roll out of a Performance Monitoring Information System (PMIS). PMIS is designed to provide a centralized repository for all monitoring data collected at SANDAG that will be accessible for those needing the information for reports, presentations, and analysis. The goal is to make sure everyone in the agency is using the same information that has been collected according to established standards and protocols. In addition, we have developed an interface that will allow access to these data by end users who do not need to be experts in the technology used to build this system. Key to this system will be comprehensive and easily understandable documentation describing each indicator, including its sources, derivation, limitations, and what it is intending to measure.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

We work closely with Caltrans on the PeMS and with our transit agencies on technologies for public transportation. Both of these efforts will greatly enhance the information for performance monitoring. These kinds of partnerships are often formalized through the federally required Overall Work Program (OWP) process and are most successful when project charters, memorandums of understanding (MOUs), or other documents are used to codify roles, responsibilities, and funding. It is our opinion that coordination between state DOTs, MPOs, and transit agencies is very important. MPOs often face fewer barriers and can implement new technologies—data collection systems quicker than state DOTs and transit agencies. As such, MPOs can serve as a useful test bed for state DOTs and these partnerships are an effective means of utilizing often limited resources.

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)? a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

With the passage of our local ½-cent sales tax extension, we have been placed with an elevated accountability standard where we need to measure the success of our planned performance measures with actual data. Improving our ability to measure our goals against a benchmark is a high priority for our region.

SANDAG uses PeMS to capture activities to help us with long-range planning, project programming, project development, and operational decisions. Currently the traffic data is collected automatically for many freeway segments every 30 min, 24/7 and placed into the PeMS system. This year in partnership with private sector, our region has placed a compliment of side fire radar detectors to close the major gaps in our region's freeway system.

Our system provides us with an accurate historical and current traffic data on our freeway system. We recognize, however that trips do not start and end on the freeway system. We are now focusing our priorities with collecting origin–destination trips on arterial systems and transit routes. We are collecting not only throughput but in some cases speed and type of vehicle (truck, bus, auto). We have also placed priority in knowing the locations of transit vehicles (AVL) and automatically counting the number of passengers (APC) on and off our transit system

Our regional transportation plan has set performance goals for projects that, when completed, will reduce travel times and congestion in the region.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

As noted in Question 1, we have created a data system for monitoring a variety of indicators that focus on broader quality of life and sustainability issues. The plan for these types of measures was not done in isolation, but was the monitoring component of our RCP. The RCP was developed over a 2-year period through a broad-based public involvement program and extensive negotiations with our member agencies and key stakeholders throughout the region. The particular indicators chosen were vetted through numerous committees and working groups and are designed to monitoring the progress of the RCP in meeting its established objectives.

2c. How do these plans incorporate broader data uses beyond performance measures?

Developing an integrated performance monitoring system like PeMS gives us the ability to provide traveler information (511) giving people alternative routes and choices to compare the automobile versus transit travel times. Counting the number of passengers 24/7 allows our operators to better plan the size and route of the transit system. Providing AVL to transit vehicles gives advanced stop notification to customers which will help with the reliability in the system. Our region's smart card will take the guesswork out of having exact change to ride the system. The card will also indicate the type of commuter and volume to help aid in the transit planning service.

3. How have individual data collection systems been developed or modified to better support performance measures? a. What factors were considered when deciding to invest in data system improvements?

- Cost and benefits of improvements.

- Ease of use and ability to produce understandable and metrics meaningful information to the public and decision makers.
- No or limited reliance on manual methods.
- Reliable technology that produces results with specified accuracy parameters.
- Extent of coverage of major transportation system facilities and modes of travel throughout the region (e.g., expanding PeMs to arterials and equipping public transportation vehicles with AVLs).
 - Expandability and compatibility to incorporate new technologies.
 - System speed and data storage requirements.
 - Capital and maintenance costs.
 - Current and potential future funding streams.

3b. Who were the key people involved and how was timely consensus reached?

We need the expertise and buy in from SANDAG, Caltrans and the region's two transit operators to be successful in implementing PM systems. The key people from these agencies include

- Planners, operation specialists, and engineers;
- Potential users of the system (internal and external to the agencies);
- Application developers and IT staff (in-house and consultant); and
- Agency executives.

We have found the following, and not exhaustive, list of strategies can help gain timely consensus:

- Set realistic goals, objectives, and priorities (get buy in up front).
- Demonstrate end products that meet project objectives and goals.
- Establish short-term deliverables throughout implementation to measure success and keep people engaged.
 - Keep focus and avoid unnecessary/unproductive scope creep.
 - Involve developers, stakeholders, and users together and use focus groups and peer review panels.
 - Find a champion with sufficient clout to resolve conflicts and force decisions when needed (e.g., someone may not like a particular feature/function, but can they live with it?).
 - Do not let the promises of technology/vendors dictate priorities; these must come from the stakeholders and users.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures? a. Have existing tools been modified or new tools been developed?

PeMS has been both added and modified to enhance the monitoring of transportation system performance. It has been modified to show large sets of data. Before, the user could look at day to day differences effectively and efficiently, but looking at month to month or quarter to quarter trends was time consuming and cumbersome. The tool has been modified so that large datasets have been preprocessed so the user can access monthly and quarterly information more

efficiently. A new tool has been added to PeMS allowing users to understand the interface between the freeway on-ramps and the main lanes. On-ramp vehicle volume data is now fed into and accessible through PeMS.

4b. How has enterprise tool development incorporated performance measures?

PeMS is an enterprise tool developed specifically for measuring the performance of the California freeway system. SANDAG hopes to expand the capacity of PeMS to accommodate PM of transit service and local arterials. Specific performance measures include and will include: speed, travel time, on time performance, usage, and levels of congestion.

Virginia Department of Transportation Perspective

JAY STYLES

JEFF PRICE

CHRIS SNYDER

Virginia Department of Transportation

ILONA KASTENHOFER

Virginia Transportation Research Council

1. How have you used current data collection activities to feed performance measures?

The Virginia DOT is currently reporting performance measures through several different outlets, including Virginia Excels (external through the governor's office), the Quarterly Report (external Virginia DOT report), Dashboard v.2 (available on Virginia DOT's external website), and bi-monthly performance report to the commissioner (internal). Most of these performance reports utilize data input everyday by the business users of systems within the department as part of normal business operations.

1a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Dashboard 1 used existing data in existing systems. It did not require any change in established business processes and daily work activities of people in the field. It focused solely on the construction program. Most of Dashboard 2 also uses existing data but there are a few areas, such as pavement work completed, that required new data to be collected and a new process for entering and collecting that data to be developed.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

The General Assembly of Virginia passed a bill in 2005 requiring local governments to provide accounting information annually on how they spend the state money distributed to them from Virginia DOT (using formulas regulated by the code of Virginia), and to begin reporting performance measures annually. A working group from Virginia DOT and several local governments has been meeting to discuss the full implications of the bill, what performance measures would be reported, what data would be needed, and how that data would be collected. Right now, the plan is to have local governments report on pavement roughness using IRI, pavement serviceability rating, and on condition of National Bridge Inventory (NBI) bridges. These measures each use standard definitions and data that is either already available or can be obtained fairly easily. The plan is to begin with these measures and incrementally develop new measures and data collection processes.

MPOs and counties are already connecting via extranet technology to enter engineering project data into existing source systems that is displayed on the Dashboard. We are currently

enhancing this to include a new system to collect construction project data (dollars plan/spent, percent complete, contact information).

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)?

Virginia DOT began building a data enterprise system and consolidating many of its business data into a data warehouse several years ago for several reasons not necessarily related to PM. As it turns out, however, developing the Dashboard (Virginia DOT's automated PM system) was made much simpler by having the data warehouse. PM often requires combining different kinds of data (financial, project details, schedules, plans, accomplishments, etc.) to produce a single measure. The data warehouse provides one-stop shopping for data from multiple business systems that can be used to do many types of automated performance reporting. PM is now an important function within the agency and has become the driving force behind further development of the data warehouse, and more generally of strategic plans for Virginia DOT data systems.

As mentioned above, the construction program was the first area incorporated into the data warehouse. Virginia DOT is now looking at how to build a data warehouse for operations data. Completing this is a high priority, and will simplify and improve measurement and reporting for many of the new operations performance measures being developed.

In general, as the agency develops and refines its performance measures, new data requirements emerge. In some cases, this data already exists but has never been used in this way. It may not be accessible for the purpose of PM and reporting. In other cases, the data simply does not exist. It is not being collected. In both cases, business requirements are formalized for data needed for PM and requests are sent to the IT division for modifications to existing systems, or development of new systems.

2a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

Every modification to an existing system or development of new systems undergoes a rigorous user acceptance testing and audit process before going into production. Training is developed and provided to all employees on each system. Since Virginia DOT's approach to PM is to pull data directly from the source business system, the process used to develop performance measures includes consultation and input from users of the systems and processes that create the source data. By being a part of the development of the team that defines, develops and implements the measures, the business owners are well aware of the appropriate uses and limitations of the data. In fact, it is the business owners who more often point out the limitations of the data used or being considered for performance reporting.

Where performance reporting is not automated (i.e., bi-monthly performance reports on the chiefs and district administrators), verification of data quality and accuracy is more difficult. In most cases, data for nonautomated performance reports is submitted by one or more persons to the management services division, where it is assembled and distributed to the appropriate users. Data is collected a number of different ways, from spreadsheets, templates, and even emails from data owners. Still, many of these measures are undergoing further development to standardize the definitions, rules, and data collection processes, in order to improve data quality.

Former Commissioner Shucet felt that it was more important to get the performance reporting system up and running and make the information available to the public than to wait until the data could be guaranteed 100% correct. For this reason, Dashboard v.1 and v.2 went live internally first and then externally about 3 months later, even though data reviews were still going on. We found that while there were many problems with data quality when Dashboard first went live; overall data quality improved significantly after the system went live. The commissioner insisted that a single person be identified as responsible for the information being displayed. At the highest level, this is the commissioner. At each successively lower level, this is the commissioner's chiefs and district administrators, and so on down to project managers. In this way, accountability is established, the public is given a person they can contact directly with questions and comments, and employees understand what they are responsible for. This has been a major driver to improving data quality.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

The Transportation Initiative proposed by newly elected Governor Kaine includes performance measures as a means of monitoring the use of funds provided to Virginia DOT. The governor's plan calls for performance measures that address congestion, quality of life, and other hard-to-measure areas. A number of measures have been developed to address these, including travel time, travel time reliability, delay, incident duration, ROI in system operations, crashes, fatalities, safety project effectiveness, volume, speed index, volume-to-capacity ratio, ITS device reliability, and hazardous location assessments. Some of these are higher level measures than others, but they are all new (or relatively new) and require considerable work to develop and implement.

2c. How do these plans incorporate broader data uses beyond performance measures?

In reviewing and developing the above list of performance measures, the leadership recognized the need to reassess our entire operations data enterprise. We are reviewing what operations data we collect, what systems are used to collect it and how (or if) it is archived and managed. As teams work to develop the new performance measures, requirements for accessing existing data and for collecting new data are emerging. These will be incorporated into the overall review of Virginia DOT's operations data and decisions that may be made regarding modifications to existing systems or development of new systems, in light of the emerging needs for operations data.

3. How have individual data collection systems been developed or modified to better support performance measures?

As mentioned above, Dashboard v.1 and v.2 were developed specifically for performance reporting. Initially no new data collection systems were needed. However, as new performance measures are developed, especially more complex measures, requirements for some new data collection processes and systems have emerged. Where it makes sense to use existing systems, modifications are being made to those systems. Where it makes more sense to develop totally new systems that is the approach being taken. For instance, incident data is collected in one

statewide system [Virginia Operations Information System (VOIS)], and several other local systems. A lack of standardization in the number and definition of data fields collected has made statewide incident management reporting difficult. To address this, a major overhaul of VOIS is ongoing and will result in a much improved system for statewide incident management reporting.

3a. What factors were considered when deciding to invest in data system improvements?

How much will it cost, can it be done in house or should it be procured from a vendor, what impacts will it have on data entry, data quality, and overall business process efficiency? Also considered are who will use the data and for what purposes?

3b. Who were the key people involved and how was timely consensus reached?

The business owner(s), the chief(s) over the business owner(s), the head of the IT division are generally the key people involved in decisions about developing or modifying data systems in house. If the system is to be procured from an external vendor, the IT division will evaluate the impact the system may have on Virginia DOT's operating system and existing data environment, but may not be involved in the investment decision.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures?

Yes, see discussion about Dashboard v.1 and v.2 above. There are plans to expand the use of GIS data in order to display geographic performance information. This requires a tremendous amount of work to establish the base map and begin overlaying data with spatial coordinates tied to the base map.

4a. Have existing tools been modified or new tools been developed?

As mentioned above, Dashboard v.1 and v.2 were developed specifically for performance reporting. The next generation Dashboard is under development now and will incorporate more measures and more features for displaying performance information.

4b. How has enterprise tool development incorporated performance measures?

Again, as mentioned above, Virginia DOT's approach to data enterprise development is key to its ability to implement automated performance measures. The goal is to have all performance measures automated using data enterprise tools developed in house by Virginia DOT staff.

Washington State Department of Transportation Perspective

DANIELA BREMMER

Washington State Department of Transportation

1. How have you used current data collection activities to feed performance measures?

a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Invariably, data improvements efforts (of which the WSDOT has many) will benefit PM and reporting but there is no direct, explicit linkage between performance reporting needs and data collection or data base development. This is largely a function of limited staff and resources, outdated IT systems and evolving PM needs. At this time, WSDOT databases are not designed to include data that is specifically or solely for PM. But many measures of performance can be supported from the data used for business operations.

For example, WSDOT expects that many performance measures can be derived from the data marts (see Question 3) especially as measurement needs mature, become better defined and are or more predictable. External (such as legislators) and internal (such as agency management) customer needs are dynamic and may change frequently. They also require more immediate turnaround, making longer-term data base development options difficult.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

Other than some urban congestion measurement, there is no formal partnership

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)?

2a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

See Question 3.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

No such plans or needs.

3. How have individual data collection systems been developed or modified to better support performance measures? a. What factors were considered when deciding to invest in data system improvements?

Cost, time to complete and likelihood of success are key factors. The inherent need is seldom the issue, there is almost always consensus that “we need better or more data!”

WSDOT recently placed selected mainframe data and other sources of data into three data marts that are linked together. As a result, roadway geometrics, traffic, and collision data are now available to be mined using Hyperion. WSDOT also recently placed a lot of this data into a GIS environment at the request of the programming–planning business side to develop new strategies for planning and then also to scope projects. The quicker access to this type of data allows users to answer some performance-related questions in regards to the highway system.

In general, the data warehouse initiative is providing information that managers have been requesting for years. WSDOT derives data from the original source systems—the so-called “legacy” systems—and reformat it for convenient and versatile querying. WSDOT is building the data marts one business area at a time as funding becomes available, using a unifying system architecture that will ensure that all the data fits together. This means that one can construct a report about a business problem without being limited by the boundaries of the source systems.

Data marts are designed to be very versatile, so that various kinds of measurements can be obtained. If an identified measurement data were not available in the data mart, it might be derived from the source system by modifying how the data mart is populated. If the source system lacks the needed measurement data, that system would need revision.

The one area where major investments are considered is project delivery measurement and reporting. Legislative needs for managing projects, and enhanced reporting and accountability needs associated with two big revenue increase packages have made this a high priority.

Recently, WSDOT completed the Critical Applications Modernization and Integration Strategy Project, undertaken as directed by a 2005–2007 Legislative Proviso. Eclipse Solutions, a consulting firm, examined 11 core technology systems which provide WSDOT both direct support of capital projects and information necessary for the agency’s accountability efforts. The study evaluated the systems from both a technical and business perspective, indicating how well they are fulfilling the agency’s business needs.

According to the study, none of the eleven critical applications met even 20% of the agency’s current and future business and technical requirements. WSDOT is currently addressing the unmet needs through tremendous manual effort and use of multiple ad hoc systems. According to the study recommendations, WSDOT needs to replace 11 critical applications to achieve significant, long-term improvements in transportation investment decision making and day-to-day capital project, capital program, and financial management.

3b. Who were the key people involved and how was timely consensus reached?

In general, data experts, customers, and IT staff (project manager, developers, infrastructure, and support) are involved in any enhancement or new project discussions. Timely consensus is reached using project management techniques. WSDOT has an internal data council that prioritizes the resources available to modify systems.

For the larger scale project management and reporting need, a series of external performance audits validated WSDOT’s requests and needs to replace many of the legacy IT systems to provide timely project management and project delivery information. After many audits and years of reviews, WSDOT has internal and external consensus but needs legislative funding to move forward:

The study provided recommendations for a modernization strategy for system improvements or replacement. This strategy utilizes a phased approach to ensure WSDOT can

effectively deliver a system replacement initiative of this magnitude. The timeline extends over three biennia with the first phase in the 2005–2007 Biennium. Phase 1 included a feasibility study of 11 of the existing legacy systems and the establishment of the technical architectural foundation.

The results of the critical applications modernization and integration strategy were presented to the Office of Financial Management, Information Services Board, and the Washington State Legislative Transportation Committees in December–January 2006. A supplemental budget funding request for Phase 1, the feasibility study, was not successful in the appropriation process; therefore, WSDOT is currently considering other options to continue the momentum of the project until funding can be obtained.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures? a. Have existing tools been modified or new tools been developed?

WSDOT is in the process: The GIS Workbench and ArcMap GIS are being used to display and analyze some performance data. The capabilities of GIS and the desire to use it for performance data analysis (so far very limited) have created an increased awareness of the value and need for accurate location data to be incorporated into enterprise databases. Without consistent methods of specifying location, data from various silos cannot be integrated for performance analysis. Planning for retooling of critical databases includes requirements for location references and the systems that maintain them. Tools are in development that will facilitate standardization of location data and collection of accurate location data and, at some point, better PM.

4b. How has enterprise tool development incorporated performance measures?

Hyperion Intelligence was selected as a query tool about six years ago; specifically because it is a vendor-neutral database access tool that can do virtually any kind of report building from any mainstream data source. It is a complement to the GIS Workbench, so that knowledge workers have both tabular and geographic data readily at their disposal.

GIS use for PM has been an identified need but not a high priority in relationship to the more significant project management IT needs. WSDOT just started to display performance data using GIS and expects to do much more in coming Gray Notebook performance reports for congestion and safety.

Washington State Transportation Improvement Board Perspective

STEVAN GORCESTER

Washington State Transportation Improvement Board

The Washington State Transportation Improvement Board (TIB) is an independent state agency that provides grant funding to local government street and sidewalk projects. The agency has 455 projects in its current inventory and selects about 70 new projects per year.

QUESTIONNAIRE RESPONSES

1. How have you used current data collection activities to feed performance measures?

Our initial performance measures efforts focused on mining measures from our Structured Query Language (SQL) project database. Initial results helped us identify database improvements that brought the data we collect more in line with the data we measure.

Our grant programs require applications and progress reports from local agency customers. Application information and data requested on progress reports were modified to coordinate with performance measures.

Where performance measures input could not be obtained from our database, an intranet user interface was created to allow for direct data input by staff.

1a. How do the data collectors in your organization incorporate performance measures data requirements in their overall data collection program?

Our approach has been to integrate performance measures data collection into routine daily business practice. We have avoided separate staff activity to “populate your performance data.”

Modifications made to database fields and customer reporting helped to integrate collection of the necessary data into routine project administration tasks. A small amount of unique tasking was required to, for example, move financial system data over to the performance management system.

1b. How has your organization partnered with local governments, MPOs, and tribes in developing data sources for system performance measures?

Our local government customers report on project progress using electronic forms provided by our agency. The forms are transferred to our project database and the data is mined by our performance management system.

Our performance measures research includes case studies with customers to determine local impact. Customer surveys are conducted at project closeout to determine staff performance and the extent to which projects meet customer needs.

2. How do you plan and prioritize improvements to data systems involved with PM (for example, development of data business plans)?

Improvements and modifications to performance systems are determined and prioritized by an internal performance team operating within an overall business process improvement (BPI) program that includes several implementation teams for each BPI subject area.

Thus far, most IT system improvements, including creation of our Performance Dashboard Intranet application, have been completed using staff time and overtime. Some individual components of the project have not been implemented due to priorities set by the performance team.

The agency has a data business plan that includes the performance dashboard software and its upgrades.

2a. How do these plans, or other activities, improve or audit data quality, and help users understand appropriate uses and limitations of data?

The performance team monitors data quality, reporting format, and data limitations and incorporates agency response into its priorities. Management reports on performance status and data issues at each of six annual board meetings.

2b. How have plans been developed for more complex performance measures such as quality of life and sustainability?

Our performance team has several projects to develop new performance measures. The two complex measures currently under development are time-lapse metrics that require data collection before a capital project and three years after completion. Obtaining data for time-lapse impacts on land value and accidents are two current priorities.

2c. How do these plans incorporate broader data uses beyond performance measures?

The data is used in a range of agency communication activities including newsletters and our annual report. The data is used to report progress and efficiency to the state governor and legislature and to support budget requests.

Our Performance Dashboard software is used to report to the board, particularly on fiscal measures. This interactive reporting approach has greatly improved board confidence in project and financial controls.

3. How have individual data collection systems been developed or modified to better support performance measures?

TIB manages about 500 grant projects using a SQL database to track all project and customer information. The database was expanded to include fields or separate fields to isolate data needed by the performance system.

New business practices were instituted to create data sources not previously available. For example, the date of incoming transaction requests were not tracked previously. We were able to establish a transaction time performance measure by dating all inbound requests and setting a processing expectation for staff.

3a. What factors were considered when deciding to invest in data system improvements?

New management found the agency seriously out of balance and at risk of defaulting on financial commitments. Performance management was applied to establish a balance between project interests and financial sustainability.

The governor subsequently instituted a new performance management program for all state government, a directive TIB was able to meet with current activities. In 2006, state voters enacted a sweeping performance audit program so we have plenty of impetus for PM.

3b. Who were the key people involved and how was timely consensus reached?

Management, IT, and performance team members were the front line of developing performance measures.

Full consensus has not really been achieved. Performance Management is not an event, but an evolutionary process. Most staff sees the role of performance management in achieving a balanced agency with legislative support. A few still think that management considers it more important to meet performance targets than build projects.

4. How have tools for displaying or interpreting data (such as GIS and microsimulation models) been incorporated into the development of performance measures?

Our performance management approach evolved in three distinct steps. We started with no data and moved to manually manipulating data using Excel. The manual process gave way to regular automated Excel reports and then to creation of the Performance Management Dashboard Intranet application. Please see [Figure 1](#).

4a. Have existing tools been modified or new tools been developed?

As described above, the existing SQL database was modified to support certain performance data.

An Intranet application was developed using Macromedia Cold Fusion to display performance data in real time. The application uses Extensible Markup Language (XML) technology similar to the now common news pushing subscriptions available on the Internet. The system uses XML to call for data from the SQL database and recalculates measures each time a page is loaded.

4b. How has enterprise tool development incorporated performance measures?

Same as above answer. The SQL database and Performance Management Dashboard are Enterprise applications.

TIB PERFORMANCE MANAGEMENT

Five years ago, the TIB was running \$35 million in the red and canceling projects due to outdated financial management. The agency, which issues transportation grants to local governments, used paper spreadsheets to hand adjust over \$100 million per year in planned

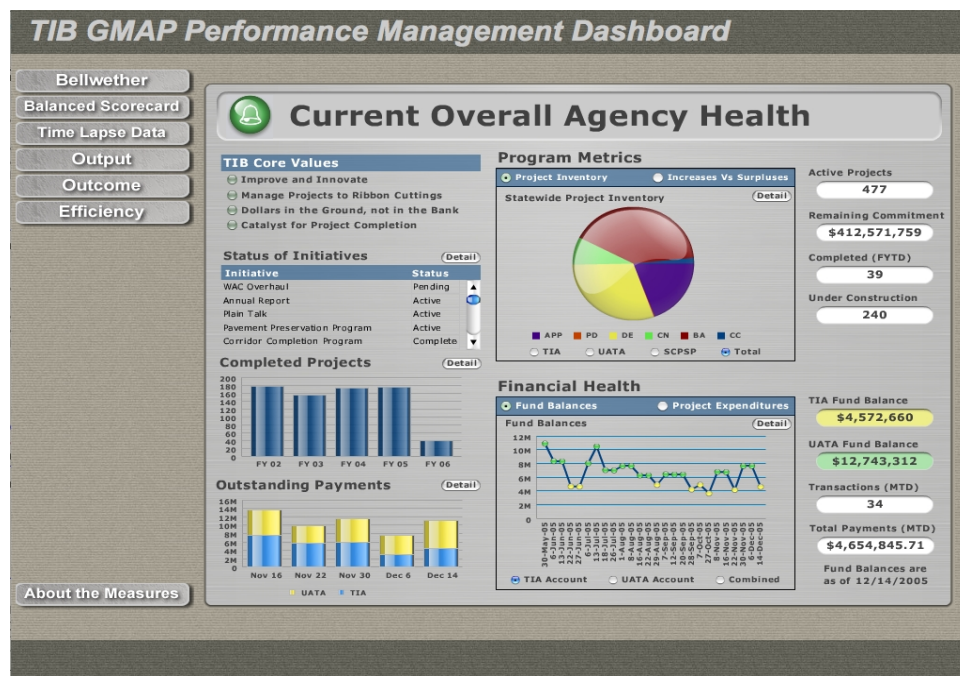


FIGURE 1 An example of the Performance Management Dashboard Intranet application

expenditures. Monthly staff reports to the agency's board provided only cryptic financial data. At one point, project inventory exceeded today's performance target by more than 400 projects and payments were delayed up to 5 months at the end of the 1999–2001 biennium. The agency and its projects suffered from a lack of an automated financial system and performance monitoring.

Learning from the Data and Setting New Targets

Beginning in 2001, new management established automated financial systems, completed a balanced scorecard strategic plan and initiated new financial and administrative policies. The project inventory was reduced by more than 400 projects by setting performance benchmarks and pursuing resolution of many delayed projects.

The agency eliminated its deficit and reduced overprogramming from 175% to 110%, a manageable level given the timing and history of project expenditure patterns. Timeline benchmarks for accounts payable helped establish necessary discipline in the processing of payments.

The data from 12 years of project activity revealed historical patterns that proved invaluable to forecasting when the approved projects would actually demand payment. The data showed that demand for funds peak an average of 4 years after the initial project approval. The director asked staff to develop a financial demand model using the pattern of past expenditures. The model was tested against project sets with already known outcomes and proved that it could predict the likely expenditure demand within acceptable statistical tolerance.

When the data started to be used by the agency, it became much easier to recognize and address potential project and data management problems. Corrective actions were taken to improve the timeliness and accuracy of the information and a more expansive PM effort evolved.

Demanding Specific Actions

The director worked with staff and board members to come up with solutions to close the gap. This included working with customer agencies to solve project problems and communicate performance expectations, particularly construction timeline. The more projects adhere to a performance schedule, the more stable cash demand would become. All agency attention was placed on developing sustainable business practices to ensure the integrity of public funds and the reliability of project completion. Specific measures included:

- Adopting broad new operating policies to prevent hidden inventory and financial problems.
- Establishing transparent financial reporting to the board.
- Using financial demand modeling to establish a sustainable number of new projects.
- Reviewing project inventory to close out completed projects that were tying up fiscal capacity.
- Establishing project closeout expectations were established for staff.
- Negotiating the withdrawal of long-delayed projects that could not move forward to completion.
- Curtailing funding increases for project overruns to stay within available surpluses from under runs.
- Recovering a net surplus of funds to help correct the deficit.

Taking a New Approach

One of the first lessons for establishing a strong agency was to think like a bank rather than a transportation agency. TIB could only be a great transportation agency after becoming a great bank. Former thinking was that the agency would always do what was right for the project, such as always approving increases even when the project would continue to be delayed. Revised thinking placed the emphasis on fiscal strength; the ability to make payments is critical to the success of the projects.

Most significantly, the attention of the agency was refocused from awarding new grants to completing projects. This seemingly minor distinction changed the approach and actions of agency staff. Limited capacity for cost increases is now targeted to projects that will go directly to construction. Staff spends much more of their time identifying project issues and helping customers come up with solutions. Today, TIB business decisions follow its core values:

- Improve and innovate;
- Manage projects to ribbon cuttings;
- Dollars in the ground, not in the bank; and
- Catalyst for project completion.

Following Up

TIB now uses a real-time performance management dashboard to monitor targets and display data for the use of all staff. The software application responds to Governor Gregoire's GMAP Directive (Government Management, Accountability, and Performance Program). Through the

dashboard, all staff have continuously updated performance data in graphic form on their desktop (Figure 2).

The dashboard monitors agency metrics and alerts staff to developing problems. Data that once had to be extracted from spreadsheets or were not available at all are mined automatically from the project database and financial systems. The agency sets aggressive project and administrative targets and tracks them daily to ensure strong management control.

Responding to Lessons Learned

Performance management has already changed many business practices, rules and programs. Some key lessons learned from data analysis resulted in new, more effective approaches to completing projects are reflected in Table 1.

The 2005 Legislature provided TIB with additional funding from a 9.5-cent gas tax increase. The additional funding was used to complete the final stage of eight urban corridors across the state. Each of the projects will make a real difference to traffic conditions in their regions and may not have been funded without the information provided through GMAP and a new focus on project completion.

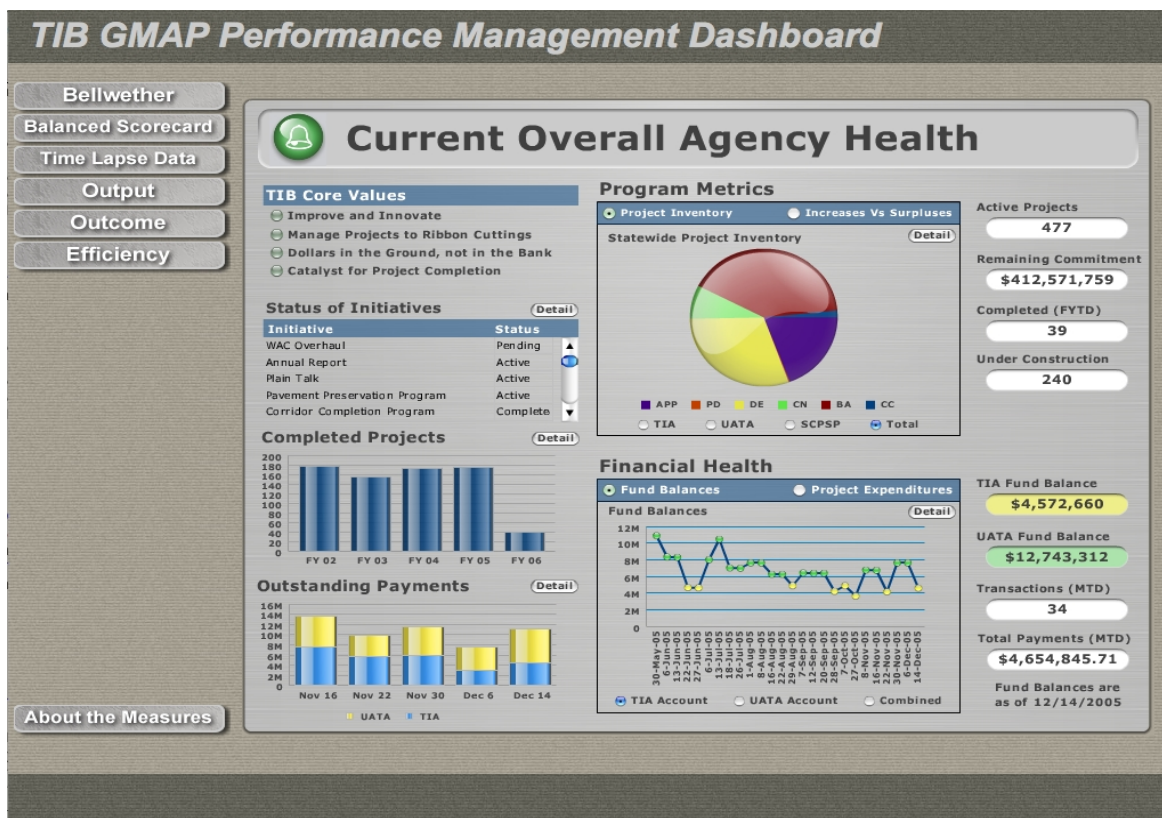


FIGURE 2 Updated performance data in graphic form.

TABLE 1 More Effective Approaches to Completing Projects

Lessons	Actions
Excessive inventory	Closeout completed projects Manage delayed projects
Urban corridors taking too long to complete	Increase grants to extension projects Fund final segments Corridor Completion Initiative
Small city projects were too small	Eliminate arbitrary funding limits Complete projects between natural termini
TIB contribution per project was dropping while costs rose	Reduce very small percentage investments Select fewer projects
Unsuccessful customers	Enact a contact management policy.

BREAKOUT SESSIONS

Themes for Discussion

The workshop included sessions for three breakout groups composed of the same participants throughout the day. The discussion themes were designed to serve as a guide for discussion, with groups having considerable leeway to define issues as they felt best based on their collective experience. Each group started with the data challenges theme first. Then each group concentrated on their assigned priority theme in detail. Other themes were discussed as time was available.

The individual group theme assignments were as follows:

- Group 1: Plans and Decisions to Improve Data Systems for Performance Measurement; Lance Neumann, facilitator; Robert Copp, recorder.
- Group 2: Integrated Systems for Accessing, Analyzing, Displaying and Reporting Data for Measures; Jack Stickel, facilitator; Debbie Mah, recorder.
- Group 3: Advanced Technologies for Data Collection in Operations; Mark Larson, facilitator; Sandy Straehl, recorder.

The following three sections represent the summary of the discussion and the detailed discussion notes for each breakout group by theme. Each section also contains specific high priority issues for future research identified by each breakout group. These issues were presented to all attendees at the end of the workshop and provided the basis for development of the final research problem statements.

BREAKOUT SESSIONS: BREAKOUT GROUP 1

Plans and Decisions to Improve Data Systems for Performance Measurement

LANCE NEUMANN

Cambridge Systematics, Facilitator

ROBERT COPP

California Department of Transportation, Recorder

PARTICIPANTS

- Lance Neumann, Cambridge Systematics, Inc., Facilitator;
- Robert Copp, Caltrans, Recorder;
- Rina Cutler, Pennsylvania DOT;
- Alex Estrella, SANDAG;
- Stevan Gorcester, Washington State Transportation Improvement Board;
- Randy Halvorson, Minnesota DOT;
- Ilona Kastenhofer, Virginia DOT, Virginia Transportation Research Council;
- Lisa Klein, MTC;
- Jeff Price, Virginia DOT;
- Gary Sanderson, Idaho Transportation Department;
- Jay Klagge, University of Phoenix; and
- Barna Juhasz, FHWA, Office of Highway Policy Information.

SUMMARY NOTES

Group 1 used two questions to guide their very energetic discussion. First, the general question on data challenges for measures was used as the backdrop followed by plans and decisions to improve data systems for PM. While the specific questions were not always directly answered, a wide-ranging discussion, where group members built upon and challenged each other's statements, was held. The following paragraphs summarize the key issues that were discussed. All the details of the discussion are included in the next section.

The group began by listing some of their key issues around how to use performance measures. The evaluation of project performance, system performance, and, ultimately, what the taxpayer gets for their dollars, was discussed. Developing performance measures based on current data can be problematic since legacy systems were not designed for this purpose. While some steps can be taken to begin to show indicators and outputs versus real measures and outcomes using these legacy systems, the first steps should be to design the PM system, agree on definitions, look for gaps, begin to integrate data silos and turn off legacy systems, and determine how to add new SAFETEA-LU data requirements. To make effective decisions using performance measures, a clear definition of the use of measures is desirable. Will the measures

be used to discuss trends and look for continuous improvements of processes? Or, will funding allocation decisions be made? At the end of the day, and with whatever process you pick, the goal is to improve the performance of the system.

The development and use of complex and broad societal measures, such as economic development and quality of life, were discussed next. Measures such as economic benefit of a transportation project (including measures such as job growth) are important to political leaders. They are difficult to measure and outside the core responsibilities of transportation departments. Yet, it is important to show the value of a transportation investment. It was noted that these complex measures could better be collected by a state planning agency that crosses all state departments. Due to the size of the transportation departments, they are often asked to collect this information. It is critical that the transportation departments explain what parts of these complex measures are in their control and what significant parts are outside their control.

The next discussion area focused on centralized versus decentralized data to support performance measures. While it was clear that data collection is often and probably should be decentralized, data standards would allow for data integration. If data is to be collected in one place and used in multiple places, it is desirable to achieve a better understanding of data. Many in the group felt that standardization is beneficial, but there was no single view on how to achieve it. Some members of the group wanted some discussion to attempt buy-in, and then a strong leader would make the decision. Others thought a data czar is needed, at least initially, to set the standards and get things going forward quickly. Once the structure is in place, a more decentralized operation would be possible. Finally, others supported collaboration and sharing of activities so others can choose on their own to move to the new structure. An example of this collaboration was regular meetings of functional managers to discuss and analyze their performance and look for trade-offs. While a data czar might lead a data revolution, the changes may not last if buy-in is not achieved or the value of the change is not clear. A collaborative approach may take longer to achieve department standardization, but once it is in place it is more likely to last for the long term.

A final topic area was how IT business plans and data business plans support the implementation of a PM system. It seemed obvious to some that these plans are needed and no further discussion was warranted. Yet, some thought that understanding when and how to develop these plans was an important step. Also, why doesn't everyone have a data business plan if it is obviously needed? Ultimately, many in the group agreed that developing a PM system includes business planning steps. It is important for IT and data managers to work together to develop these business plans. They should develop a governance process, improve data quality, build internal and external buy-in, and assign appropriate funding and staffing. The IT managers understand the technology while the data managers understand the business needs.

DETAILED NOTES

Data Challenges for Measures (All Groups)

What are important measures where are you experiencing problems with data systems and data quality?

- Time lapse data—project performance, 2–3 years later to get the delta.
 - Entails a customized system for each effort.
 - Did the intended result actually occur?
- Many different perspectives—need a systematic setup.
 - Whom are the measures for?
 - Different parts of organization focus on separate pieces.
 - Is there a flow chart or picture of the system?
 - Framework could help set priorities on developing measures.
- Real-time traffic operations data has not been developed.
 - Need data quality improvements to build credibility.
 - System issues – For example, use current traffic counts or develop new data.
 - Do we outsource or do it ourselves?
- ROI, economic vitality.
 - Regardless of type of project, what does taxpayer get for dollars spent?
 - Need to deliver on funds provided (e.g., sales tax measure).
 - Independent taxpayer oversight committee.
 - Develop the measures ourselves or are they mandated by legislature?
 - More difficult if need is to develop measure without direction.
 - Political leaders may not understand impact of others on measures.
 - What are these things outside our control?
- How far should we drift from the core we control?
 - Other measures, like environment, are impacted by others.
 - How can we not go beyond the core?
 - Congestion is impacted by others.
 - Determine the degree of influence of transportation industry.
 - Determine scale of influence by whom.
 - e.g., air quality improvements have come from vehicle and fuel.
- Predictive capability of measures—needs a lot of work to develop
- Partnering for measures.
 - Safety is a poster child for this.
 - May need to extend beyond the transportation community.
- Dangers of promoting performance measures—beyond data availability and influence of agency
 - Rather set a goal versus setting a general direction.
 - For example, improve by 10% per year versus just improve it.
 - Can we show we are actually doing better and by how much?
 - What is the baseline?
 - Improvement of level of service may not occur.
 - Too many people, too many cars; we may not be able to build our way out of congestion.
 - Should our goal be to reduce the speed of degradation instead?
 - If assumptions underlying the plan don't hold, changes results—should understand these assumptions.
 - Understanding the needs and agreeing on them, changes the debate—focus on how to get the funding versus what the needs are.
 - Struggling on measuring congestion.

- Floating cars versus loop detectors versus toll tags.
- How to fill gaps? How to match to past trends / data?
- Cut tie to legacy systems.
 - Difficult because new system will likely have different results.
 - Identify the break in moving to new system or new measure—it is important to make the transition.
- No clear sense that any one type of project is better than another: How to select one over the other.
 - Disconnect between silos of data.
 - Legacy systems are from the highway side.
 - Should be more IT focused.
 - How should data be controlled?
 - Desirable to have global definitions to drive discussions
 - States are required to collect inventory data on all public roads.
 - SAFETEA-LU requirement.
 - Often requires partnerships.
 - Huge new workload.

To improve data quality some organizations have agency-wide standards and tools, while others delegate it to program areas. What is your approach and why?

- Integrate data collection and performance analysis.
 - Institutionalize into a daily business practice.
 - Should be seamless.
 - Extract from existing databases.
 - User enter data directly into the systems (financial performance and capital performance).
- What data do we have? How to use to support performance measures?
 - What gaps do we have?
 - Assessment of data, what is quality, where is it, what is missing?
 - What data do you need to measure your effectiveness?
- How we discuss internal measures, external measures, etc.?
– Do we have ways to understand what we are discussing?
- Do you live with the constraints of your existing data? Or, do you start with your needs first?
 - Most states are decentralized and not going toward centralized
 - Data quality is a bigger issue now that data is in front of senior staff
 - Start with performance measures, data is just a tool. In other words, performance measures should drive the data.
 - Centralize strategic view of what you collect and what it is for; decentralize data collection.
 - Desirable to define data.
 - Ask for data and get multiple results unless process is defined—if process is defined, everyone calculates results in a different way.
 - Should have centralized, standardized, definitions.
 - Should have centralized structure for data warehouse.

- Data should not be changed once in the system.
- This is really standardization not centralization.
- Use a process where each district talks about their costs at the central level.
 - As they present costs, they learn and move to uniformity.
 - Process is collaborative versus one czar forcing standardization.
- Vast amounts of data coming in from many locations.
 - Czar reviews data to ensure it is consistent.
 - Parameters and quality should be the same.
 - Identify who holds the data and where.
 - Brings everyone together to make consistent reporting.
- Standardization versus centralization is often beyond organization—not just state level, also at federal level.
 - It all depends on what you are using the data for.
 - This leads to the definition being developed.
 - The devil is in the definition.
 - Collect for one purpose but used for other purposes—this creates confusion.
 - Centralized strategic thinking
 - How do you make use of operations data for planning purposes?
 - Cannot just move to get the data out without knowing all the purposes.
 - Cost to collect, store, and create data is high—limited support for resources.
 - How can data be standardized within the existing silos?
 - For example, number of lanes is difficult to define.
 - Partnering is a good thing (working collaboratively)
 - Yet, at the end of the day, someone should make the decision.
 - Input on the front end and then after discussion, make a choice.
 - Strong leadership is desirable to make these decisions.
 - Get a lot of feedback on basic direction.
 - Then make a decision on how measures are defined.
 - Then programmers develop system.
 - Strong leaders come and go.
 - When they leave, so do the deals.
 - You should have buy-in to definitions.
 - Choices should be of proven value.
 - Answer is yes—standardization should be centralized.
 - Solution: Institutionalize the data.
 - Project life is calculated from start date and end date; standardization is needed, for example, on what is end date.
 - Enter key data fields without making it your job.
 - Describe your transportation system (number of lanes, auxiliary lanes, ramps); then calculate number of lanes and lane miles.
 - Set up meeting for safety, pavement, bridge, and congestion managers.
 - All report and analyze performance measures together.
 - Allows for discussion of funding trade-offs.
 - Monthly videoconferences with district administrators.
 - Explain why performance up and why down.

- Define all tiers of accountability (governance); who is responsible for each area of performance?
 - Bring to see how data is shared, transmitted.
- Create a new corridor manager at state level to work with regions. Then, begin to discuss types of data.
 - Gaining trust with other others to share data.

What are your successes or challenges forming partnerships for data collection or shared measures, either internally, or with local and regional governments, or others?

- All local agencies using state pavement management system.
 - Offered for minimal cost with support.
- State requirements to report on “books” and now performance to be reported.
 - Localities suspicious and nervous.
 - Start with HPMS as current data and bridge inspection data.
 - How to standardize data definitions and then collect it?
- How to allocate funding between districts?
 - Increasing some and decreasing others.
 - Are you awarding good performance or bad performance?
- Legislation required reporting.
 - Resources provided to provide data (software and collection).
 - This led to allocating resources.
- Should have a balance in partnering versus leadership (decisions).
 - Discussion is needed to work toward buy-in.
 - At some point a decision is necessary.
 - We have not found this balance.
 - Desirable to have a standardized structure to bring people to the table.
 - Desirable to know who is responsible for the ultimate decision.
- Centralized office of data—is this wrong?
 - Planning, design, construction, maintenance, etc. data could be managed.
 - Central office could start and bring people together.
 - Once it gets going, it can continue in a more decentralized way.
 - Senior leader of agency ultimately is responsible.
- Evolution versus revolution.
 - State providing leadership by beginning to use measures.
 - Let county measure when they are ready.
- Once institutionalized, it should be centrally managed.
 - What are the organizational issues?
 - Who is the entity who can solve the problem?
 - Who helps those not complying to be successful?
 - Who puts data into “red, green, and yellow lights”?
 - Not policing, it is about continual improvement.
- At the end of the day, we want to improve the performance of system.
- Breaking down the silos.
- Governance (How stakeholders interact and in what format).
- Quality of data (assuring quality; integrity of the data).

- Even with clear definition, quality still changes over time.
 - Reduced resources, changes in DOT organization–personnel.
 - Does this need to be policed?
 - Should develop parameters that alert to quality issues.
- Internal and external buy-in.
 - Even in organizations heavily into it, still missing some buy-in.
 - Misunderstanding of just making charts versus making decisions.
 - Make customers aware of usage of data.
- Funding and staffing.
 - Provide resources to institutional performance measure program.
 - FHWA provides SPR funds for this purpose; sometimes SPR funds are redirected for other purposes.
 - Is collection of data contracted—for example, private travel time data?
 - Educate top management on resources required: .5% for data program proposed in SAFETEA-LU.
 - Approved by FHWA, OMB, administration.
 - Cut by Congress.

What data sources might be used for “complex” measures areas such as land use and land value, quality of life, environment and sustainability?

- Broader societal measures—not just transportation oriented.
 - Are these important enough to focus on?
 - What is transportation’s role?
- Indicators should be used to monitor trends where we have indirect impact.
- There is a value to these complex measures.
 - Legislature tends to be interested in these—for example, job creation.
 - Start by doing the background research to understand these measures.
 - If I knew the answer to this, what would I do with it?
- State planning agencies versus DOT planning.
 - DOT has significant staff and funding, so end up measuring for other agencies.
 - State planning agencies are desirable for these broader complex measures.
- Quality of life may be more important than engineering standards—for example, improving a structure increases truck traffic.
 - This lowers perception of quality of life.
 - But public still has desire to improve the structure.
 - How do we manage and understand this quandary?
- Strategic measures versus operational performance measures.
 - Public versus internal.
 - Strategic are more complex and more difficult to measure.
 - What is causality of transportation versus quality of life?
 - Potential area of research.
- ROI from safety improvements.
 - Data reside in different systems in some transportation departments.
 - Desirable to integrate this data for complex measures.
- How to do market research to solicit public opinion.

- Customer satisfaction measures.
- More complex to measure than it appears.
- How you ask the question and how you interpret.
- Benchmarking customer satisfaction is difficult.
- Two projects: quality-of-life project versus quality of life–community development (generate taxes, create jobs) project.
 - Qualitatively select the second one even without detailed data.
 - Bike paths are quality-of-life projects that do not necessarily generate taxes or create jobs. ROI would likely not support bike paths.
- Evaluation: Three year post evaluation of economic growth around a project.
 - Versus the larger region (whole community).
 - Uses assessed evaluation.
 - Results used to convince decision makers that this is an investment worth making.
- Performance measures versus indicators.
 - What is the relationship between the indicators and performance measures?
 - What are the benefits of an investment?
- Sprawl versus compact development.
 - Economic environment created sprawl because economy grew.
 - Was it really unsuccessful?
 - It was a sign of a strong economy.
 - However, was it sustainable?
- What does sprawl development do to transportation infrastructure?
 - \$200 million road will not function in 20 years (4 h congestion).
 - Show how continuing sprawl growth will lead to congestion.
 - Show local decision makers the impact of their decisions—system performance impacts.
- Regional comprehensive plan, including energy issues and other complex issues.
- ROI comes not just from new development but redevelopment.
- Complex measures are very important.
 - Work to understand them.
 - Begin to look at as indicators and get trends.
 - Critical to selling transportation investments—customers may be most concerned about these measures.
- Caveat—many studies have gone before to implement economic measures.
 - Why haven't we done it?
 - Example: Performance measures scan.
 - Australia—tremendous drop in fatality rates.
 - Mostly noninfrastructure improvements.
 - Our focus has been on infrastructure

Plans and Decisions to Improve Data Systems for Performance Measurement: Group 1 Assigned Priority Theme

- How and when should organizations develop data business plans?
- When should a data plan be utilized? What criteria are used to select data/information technology investments? Are the criteria related to organizational strategic priorities and measures?
 - Operations and maintenance working together.
 - Inability to answer questions from legislators.
 - Many questions had different answers, no tools, no definitions.
 - Highest priority performance measures developed.
 - Reduce duplication of efforts.
 - Secondly, address integration across the department.
 - Limited resources—competing for IT resources.
 - Can't articulate business requirements for performance measures.
 - Have not been able to set definitions.
 - What functionality, what is it used for?
 - No business warehouse, no integration of data.
 - Legislature asked "What did IT spend?"
 - Couldn't answer—definition not clear.
 - Governance.
 - Who is owner, what is purpose, what do we want to do with it?
 - Each operations group may need a separate plan.
 - Then roll-up into department plan.
 - Information strategy plan.
 - Where will we go with IT?
 - Control and govern IT spending.
 - Governing body chooses IT projects and identify benefits.
 - IT strategy versus data strategy.
 - Data management plan touches IT.
 - IT goes beyond performance measures and data collection.
 - Information technology and investment plan.
 - Highway projects process is very well defined.
 - May need to expand to other areas.
 - IT plan versus business plan—they are different.
 - Data are a commonality.
 - Data business plan is what do we have or want.
 - Is it critical to do plan to support performance measures?
 - Functional business plans versus enterprise business plans.
 - Is this a useful tool?
 - It is amazing that the transportation business has gotten this far with business plans.
 - Data business plan is obvious, let us just move on.
 - Subquestion: Why doesn't everyone have one?
 - So incredibly well funded, so have not had to answer question.
 - Performance measures are driving the need for a business plan.

- Being forced to use data across silos—comprehensive plan.
 - The more complex and comprehensive the measures, the more a plan is needed.
- What do you measure now? What do you wish you could measure? How do you demonstrate your effectiveness?
 - What data is out there that can begin to answer these questions?
 - We have started with data we have rather than the questions.
- Not if you should do one, but when should you do one?
 - Context should be performance outcomes not just data.
 - Without executive understanding, it would be a waste of time.
- Not compelling to someone who has institutionalized performance measures.
 - Focus on performance measures.
 - Public desire for a report card.
 - How do we pay for this? We should ask the tax payers.
 - Are we spending their money well now?
 - Can we spend their money well in the future?
- Should you have a performance management system?
 - And, what will it do for you?
 - Better question than do you need a data business plan.
 - Is a data business plan part of this? Yes.
- What will a performance management system do for you?
 - Make your case to decision makers.
 - Improved business processes.
 - Communication – Show data, “Wow, looks good!”
 - Issue is are we really doing well or does it just look good.
 - Not data just for data’s sake.
 - New topic for future discussion: How do you display data?

PRIORITY ISSUES FOR FUTURE RESEARCH

What is the process for developing a performance-based investment program?

- Institutionalization of data for performance management: what and how?
 - Developing guidance.
 - Best practices.
 - A flow chart.
 - What are the tools?
 - What are the three key concepts to move forward?
 - What is the structure?
 - How do you start?
 - Part of developing a plan is the struggle.
 - It cannot be a cookie-cutter approach.
 - Prepare proposal: Randy Halvorson, Minnesota DOT.
- Quality of data, data tools, and data system integration.
 - How to improve, define, integrate, and use data?

- What tools are available and what can they do?
- Prepare proposal: Jeff Price, Virginia DOT.
- Economic ROI as performance measure category.
 - Benefits to community, economic development.
 - What is the overall benefit of making the investment?
 - Real-life applications of this analysis would be useful
 - How to translate into an implementation plan?
 - Why haven't previous studies been implemented?
 - Prepare Proposal: Stevan Gorcester, Washington State Transportation Improvement Board.

SUMMARY OF ADDITIONAL ISSUES NOT DEVELOPED AS RESEARCH PROPOSALS

- Identify linkage between performance management, programming, project delivery, operations, etc.
- Improve the state-of-the-art in performance measures.
 - Develop complex measures and improve other measures.
- How do we develop a comparative analysis between states?
 - Want to compare best practices to learn how to improve.
 - Based on common data definitions.
- Would be useful to define performance between states before others do it for us.
 - Compare performance internally and between organizations.
 - How should peer states be defined?
 - How is data defined for this process?
 - Form group to begin putting language behind definitions.
 - HPMS as possible focus to begin.
 - Build on measures that have been recommended nationally.
 - What does it take to get states to see their self-interest?
- Data business plan.
 - What constitutes a good data business plan?
- Before and after studies (time lapse data).
 - Have we achieved what we expected?
 - To drive better performance.
 - Why don't we do it?
- What are the methods to get public input?
 - Market research—public opinion as a data source.
 - More direct input from the public.
 - What do you ask them? What is the context of the questions?
 - Gauge what the public wants before asking for their support.
 - Rather than asking what projects, make a comparative analysis.
 - For example, does the public want smoother roads versus cleaner roadsides?
- Is there a need for national performance measures on the national highway system?
 - FHWA could contract to collect consistent data (or fund collection in states).
 - More like National Personal Travel Survey (NPTS) than HPMS.

- HPMS is using state data.
- NPTS is nationally collected data.
- What would this national data be used for?
 - Would FHWA require funding be used based on results?
 - This should be clear before going forward.
 - If, for 20- to 25-year reinvestment in Interstate, then could be supported by states.

KEY ISSUES

3rd TRB National–1st International Conference on Performance Measurement (June 4–7, 2007, Beckman Center, Irvine, California)

- Make it more multimodal.
- Using performance measures for decision making rather than just reporting them.
- Demonstrate dashboards (pre-conference session or poster session).

BREAKOUT SESSIONS: GROUP 2

Integrated Systems for Accessing, Analyzing, Displaying, and Reporting Data for Measures

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Alaska Department of Transportation and Public Facilities, Facilitator

DEBBIE MAH

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- Mara Campbell, Missouri DOT;
- Jonette Kreideweis, Minnesota DOT;
- Julie Lorenz, Kansas DOT;
- Warren Merrell, Florida DOT;
- Jill Reeder, Pennsylvania DOT;
- Rolf Schmitt, FHWA;
- Chris Snyder, Virginia DOT; and
- Anita Vandervalk, Cambridge Systematics, Inc.

SUMMARY NOTES

A challenge brought up by many participants is to use data in the most effective and efficient manner to support the key performance indicators identified by the respective agencies. Many agencies have only been able to respond to mandates. Typically, these mandates have prescribed the performance areas to report on. Data collection methods have been developed to meet these needs only. Agencies should be able to take a more strategic look and develop PM programs where key performance measures are identified first and the necessary data to support can be appropriately identified and developed as needed.

It was noted that agencies should also work in coordination with their partner agencies to identify the priorities within each jurisdiction and develop performance programs that will support the needs and priorities identified. Measures should enable a full transportation system network analysis. Agencies are struggling with methodologies and approaches to establish targets, establish standard values, calculate benefits, quantify benefits, quantify and evaluate causal effects. It is desirable for performance measures programs to be dynamic and strategic in nature to provide direction for all transportation stakeholders.

Performance measures should also be meaningful to the traveling public. Travel time information (traveler information) is now routinely provided to the system user. Measures should be tailored to specific audiences. Commentators observed that agencies should expand use of reliability and predictability measures and take them to the next level.

All agencies are dealing with complex measures such as land use, smart growth, and quality of life issues. However, many participants felt that these are not necessarily a priority when all agencies are in the process of establishing a core set of system measures and the data requirements (e.g., mobility, reliability, asset condition). The immediate interest is to measure what agencies can control or directly influence.

One approach to gain feedback on needs is through the use of customer satisfaction surveys. Data gathered from these surveys can be very useful in preparing business plans and setting goals and targets. Understanding the real needs of the customers (rather than perceived needs) can help establish more realistic targets. Agencies identified the need to better understand how surveys should be conducted in order to secure optimal results.

DETAILED DISCUSSION NOTES

Theme 1: Data Challenges for Measures

What are important measures where are you experiencing problems with data systems and data quality?

- Real-time data—detection systems should be maintained. Gaps in detection (e.g., PeMS).
- May need to go beyond state highway. Off-system data would be useful to get full origin–destination information.
- Other technology available to get needed data?
- Quality of data.
- Potential lack of communication with vendors who provide data resulting in not getting the data actually needed by agencies. Ensure right data is obtained.
- Need to understand what data means or represents and how management may use.
- Partnership issues—should work with MPOs or local agencies. How to identify priorities to secure the right data?
- Accurate vehicle and truck counts, quality, ensuring accuracy.
- Continuous data.
- Data priorities. Performance measures is evolving—maturing and the data needs to support is evolving also. Many times, performance measure needs are dictated by legislature, etc. Develop data needs to meet the reports requested. Have not been able to be strategic in identifying data collection and systems needs in order to develop a strategic performance management process.
- Take initiative to define key areas to measure and develop data to support.
- Organizational results versus management versus system
- How to balance investments to improve PM reporting?
- Separate set of data to establish goals? Set goals based on same data used for performance?

- Understand the benefit–cost of doing.
- Develop agility to be able to pull data for needs, i.e., marketing. Should be dynamic.
- How to measure and get to causes (mobility/congestion, as an example).
- How to set targets? No science or methodology. Based on current trends, gut, etc.

How to use? How to set? Based on right assumptions, right data. Need to be careful.

- May need a different business model. Should address dynamic business needs, causal factors, measuring counter measures/factors that will drive where agencies go.

To improve data quality some organizations have agency-wide standards and tools, while others delegate it to program areas. What is your approach and why?

- Quality control. Depends on how data are being used by management and presented to externals. Should be cleaned and scrubbed. Amount of scrubbing depends on how it may be used (use and exposure/visibility of data).
 - Virginia dashboard (project delivery). Automated data collection process to avoid manipulation of data.
 - SANDAG has piggybacked on Virginia’s system. Enhanced PeMS for region use. Will have dashboard. Corridor view with drill down to specific projects. PeMS, capital investment, rate of return, economic model. PM tied to investments made. Get expected rate of return on projects?
 - How to identify benefits?
 - Standard values for performance measures? Recommend best practice research. How to establish standard values?
 - Standardizing quality control checks.
 - Guidelines for traditional traffic monitoring are being developed (update of Green Book).
 - National way to measure reliability? Should national standard be set? Consistency on approach on how to use this information.
 - Real-time travel time data tailored to audience would be useful. Relate to user.
 - Reliability vs. predictability. Should provide more than just travel time.

What are your successes or challenges forming partnerships for data collection or shared measures, either internally, or with local and regional governments, or others?

- Caltrans–SANDAG and other MPOs, regions. Link financial systems. PeMS shared data.
- Missouri partners with highway patrol.
- Minnesota DOT—511, automatic traffic recorders (to determine high-speed areas to facilitate higher level enforcement by highway patrol). Locals can compete for state funding. Performance measures to help justify needs.
 - Alaska—weigh-in-motion (WIM), early warning of heavy load.
 - Florida—deep water ports/airports.
 - Virginia—working with MPOs to include their projects into dashboard. Ensure accountability throughout state.

What data sources might be used for “complex” measures areas such as land use and land value, quality of life, environment and sustainability and freight?

- Residents to jobs? Performance measures for?
- SANDAG—starting to address land use.
- Not necessarily a priority when trying to better develop/establish other (core system) measures.

- Measure only what we can control at this time or directly influence.
- Actionable at corridor level only? Travel time, delay, etc. affect quality of life.
- How to do a customer satisfaction survey? How to package? To increase return rate? (Suggestion made to include, in contracts, a specific return rate percentage.)

Should use data gathered through surveys. Make business changes as a result. Business plans, goals, targets. It is useful for customers to see/perceive differences/changes. Can help set more realistic targets and goals.

- Market segmentation.
- Focus groups to better understand different needs by different customers. Specific targets, groups, locations, corridors.
- Florida—ITS customer satisfaction survey.

Theme 3: Integrated Systems for Accessing, Analyzing, Displaying and Reporting Data for Measures (Group #2 Assigned Priority Theme)

Summary

Many in the group felt that GIS is the way to integrate data and performance measures. In combination, it can provide a solid basis for performance-driven decision making (in particular, programming and other budgetary and funding decisions). There is increased credibility (or perceived credibility) once data is specifically located on a map.

However, lack of progress is a serious concern. The technical issues that exist today are the same as those identified many years ago.

BI/GIS application use is very limited at this time. These applications are being used by a small number of agencies, although, many agencies are exploring the viability of using BI/GIS packages.

It was also recognized that data integration issues could increase with greater reliance on ITS technologies. If off-the-shelf applications are used (e.g., BI software), they should have flexibility and scalability. Support staff is critical. The inability to secure and retain staff with the needed skill set has impacted the ability to move forward.

It was noted that management should be educated on the benefits (benefits to managers) of using these types of systems/applications. Their support can help overcome the some of the above-mentioned obstacles.

When and why should organizations pursue such systems?

Goals and benefits—What is the payoff of integrated systems? How do you quantify benefits? What resources are required to develop and maintain systems?

- Sharing data beyond the firewall.
- Florida DOT one of the best web portals. Traffic data, roadway network, safety data.
- GIS deployment plan.
- GIS way to integrate data. How far have we moved forward? Success at state or MPO level where integrated with performance measures?
 - Credibility or “perceived” credibility increases once on the map.
 - Data integration issues as reliance with ITS technologies increases.
 - Off-the-shelf applications—scalability, ability to “shoe-horn” in, make fit.
 - Should agree on base map that all should use to put in their data.
 - One source for location data.
 - Statewide spatial data architecture being developed—Minnesota DOT.
 - Getting and keeping staff with the appropriate skills.
 - Should be simple to the end-user.
 - Technical issues need to be worked out. Same issues identified from years ago. Still the same.
 - Provides basis for project evaluation for funding—Florida

What is your experience to date? Are the commercial BI/GIS packages adaptable and effective? Provide any success stories. Where is the greatest payback (data or data analysis category with the greatest value)?

- Where are we? Have we moved forward?
- Very limited.
- Michigan, California.
- Site manager, Transport (AASHTOware).

What are your biggest obstacles to integrating enterprisewide data for developing decision support tools, e.g., scattered legacy systems, access to historical data, inadequate enterprise data plan?

- Data integration issues as reliance with ITS technologies increases.
- Off-the-shelf applications—scalability, ability to “shoe-horn” in, make fit.
- Need to agree on base map that all should use to put in their data.
- Getting and keeping staff with the appropriate skills.
- Need to have confidence that the system will enable us to still deliver.
- Internal marketing is desirable. Promote understanding of the benefits of using these systems, i.e., GIS, etc.
 - GIS very “tekkie”. Should go beyond and explain the benefits.
 - How to merge cultures (planners, engineers, GIS) to make happen?

PRIORITY ISSUES FOR FUTURE RESEARCH

1. Setting, using, and evaluating targets. Explore alternative approaches and methodologies. How to use results? How does it cycle back into the process? How to do it?

2. Methodologies on calculating benefits. How to measure the benefits? Under reporting the benefits through performance measures. How to quantify benefits (e.g., economic, others)? If you understand the benefits, can set better targets to achieve outcomes. May need to set standards. Localized values are useful. Methodology. Examples: Value of time, value of life, value of freight.

3. How to quantify influence of causal factors? Measurable effects of countermeasures to improve performance? Examples: Safety performance measure influence to congestion. Topics 1, 2, and 3 will be consolidated as one research proposal. Research Leads: Rolf Schmitt and Anita Vandervalk. (Jack Stickel and Jonette Kreideweis to assist.)

4. Sharing best practices of systems or analytical tools. Example: Florida DOT, Virginia DOT, SANDAG. Research Leads: Chris Snyder, Warren Merrell, Jack Boda.

5. Moving to the next level with reliability and predictability measures beyond traveler information and data. Research Lead: Daniela Bremmer.

6. Identifying priorities and establishing effective partnerships for off-state system performance data and systems analysis. Research Lead: Debbie Mah.

7. GIS—identify the issues that have prevented GIS from moving forward. Research Lead: Jill Reeder.

BREAKOUT SESSIONS: GROUP 3

Advanced Technologies for Data Collection in Operations

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- Aarion Franklin, Maryland Transportation Authority;
- James Golden, Florida DOT;
- Patricia Hu, ORNL;
- Vicki Miller, FHWA;
- Randy Iwasaki, CalTrans;
- Jeffrey Short, ATRI;
- Jay Styles, Virginia DOT; and
- Robert Winick, Motion Maps, LLC.

DETAILED NOTES

Theme I: Data Challenges for Measures

- Investigate funding opportunities for ongoing data acquisition for multiple purposes/users. There is a linkage between normal PM use versus the use of PM during true emergencies. Can ongoing monitoring programs be cross-funded by emergency applications?
 - What is needed to build a culture that supports data? Budget pressures may force real-time data onto the back burner.
 - How do states build a business case for data?
 - How useful are federal and third-party data sets (especially regarding freight performance) to the work of state DOTs?
- Data measures are desirable to capture and account for different types of delay, especially the level of frustration with the various types by the traveling public. For example, traffic light stops are not as irritating as an unexpected, non-typical traffic delay.
 - Mode-neutral and cross-modal definitions for congestion are needed.

- Deployment delays—Why does it take so long? What measures are effective in getting ahead of the curve? What actions are needed to avoid congestion so that severe congestion does not emerge—lessons to extract from California, Houston, or Florida.
- Data quality: what are organizations doing to improve quality that can be transferable to others?
 - How can data programs justify funding for collection, quality, and integration?
 - The biggest unknown is how does using PM change an agency's mission or influence key decisions?
 - How are PM managed organizationally. For example, how does PM impact multimodal decisions and what are the best practices in nurturing cultural change towards using PM in decision making in transportation agencies?
 - From FHWA regarding data integration in office of asset management—what is needed to define necessary technical support?
 - Focus on strategic system...need ways to understand reliability and to prioritize projects across all modes. Cross-modal and mode-neutral performance measures.
 - How best to ensure data quality across data silos and build feedback loops into performance.
 - We should investigate how to get data from real time operations and use it to extract higher level information.
 - How to make the case that data is a bargain; because it can eliminate millions of dollars of investment in the wrong stuff.
 - Applications, approaches, and best practices for using either available or the most reasonably available data to support good decision making. In other words, build skills in using what is available without developing costly and narrow new data acquisition routines.
 - How to apply measures at a corridor level (multimodal and possibly multistate)? All the options should be on the table with good data that will allow an optimal decision. What are the jurisdictional and technical issues?
 - How should a transportation agency best reward functional areas for good use of performance data in their business processes? How to institutionalize a data and performance driven culture?
 - Political versus data driven decisions. Unless decisions are based on data, then there will be no momentum for changing a culture. Is there a way to ensure an optimal balance between various PM?
 - Emerging emphasis areas that may need research: behavioral safety investments may compete with engineering investments and the performance measures are not there to support these decisions. Research is desirable to put behavioral safety investments on the same plain as engineering strategies.
 - Data is often presented in formats that are unique to various functional units and there is an inability to rollup and do cross-comparison between different data sets. How can data be adapted to be used for many different functions at different levels in an organization?
 - Emerging issue that may warrant an approach to PM: habitat and natural resource data (issue is metadata expectations, and data quality). Do we have the right expertise to scale natural resource data and consider it within broader decision-making processes?
 - Data integration: What is the payoff for having an integrated process (given the possibility of extraordinary integration costs)? Who has the responsibility for data quality? What

are the best ways to overcome data gaming? How to ensure a consistency of quality between different functional areas? How to change organizational cultures?

- Who has the responsibility for data quality and integrity? A data quality approach; shelf life for data? How can an organization improve its approach without penalizing staff? How are standards set regarding quality absent an understanding of consequences?

- What are the necessary steps to rationalize data collection and maximize what is collected in terms of quality and utility?

- How can new data collection approaches be used if there is no ground proof available to gauge accuracy e.g. data probes for traffic?

- Legacy systems: investment is too great to replace legacy systems. Systems and approaches are desirable to integrate between legacy systems.

- How are decisions made and how are systems coordinated, integrated, or rationalized? What are the organizational leadership needs to extract integrated information from legacy systems? Note: difficult to predict bridge conditions using PONTIS.

Partnering with Others: Successes and Challenge

- Success: Maryland—traveler information (511) is pulling incident information from 911 system. Geographic information is being shared on incidents between organizations (currently a single county).

- Emergency preparedness is being displayed between agencies—has situational awareness. Maryland DOT has taken lead on a GIS platform.

- CHART program was built by the state, but can be used by anyone; is successful

- Houston has a centralized freeway operations management program. Real-time travel management data, including data sharing with transit agencies.

- Costs can be excessive (\$40 million mentioned in session) if coordination is not contemplated on the front end.

- How to move management systems into the hands of the local governments? Incentives? Give them the support? How to get the local governments' needs onto a level playing field with the state's system?

- Partnering with others should happen on the ground floor. Data consistency between different jurisdictional areas entities should begin with everyone at the table. What are some models for this?

Other Themes

- What are some unused resources for data that could be easily deployed and bring value?

- Application of non-traditional measures is difficult to deploy.

- Communication to decision-makers so that a balance is preserved. Not all performance measures have the same “political” content. For example, preservation is important but may not be easy for it to compete against congestion relief.

Theme II: Data Plans

The group did not get to this theme area.

Theme III: Integration of Systems for Accessing, Analyzing, and Displaying Data

Challenges, Emerging Themes, Topics for Investigation

- A need for a new professional skill set. What are the institutional models for access to data and information? Non-specialists (i.e., non-IT analysts) should have direct access to data. There may be a need for a new professional in transportation agencies; someone who is technically savvy, knows the business processes, and can synthesize the information for real-time application.
 - This may be a tool kit or a new business skill set. This may also mean a new team approach to data flow (data acquisition all the way through decision making).
- How can metadata and archiving standards be deployed in transportation agencies?

Theme IV: Data Collection (Integrated Front-End Data Collection, Including New Technologies)

Challenges, Emerging Themes, Integrated Approaches or Advanced Technologies

- FHWA is adapting communications technologies to capture transportation freight flow information with an emphasis on identification of bottlenecks. There are legal use questions and applications questions that should be resolved. What needs to happen to extract the most information from this data? Hurdle: privacy and applications.
 - Legal research is desirable to understand how to protect the use of data. What model codes are used to be able to use proprietary data?
 - Research into using data that is seen as proprietary and private would be valuable. The use of this data could open up doors for a lot of information. What are the best approaches to handling this? What are the approaches that have/have not worked (possible synthesis). Work on cell phone probes is underway.
 - Identify gaps in current research that is going on relative to using probes to monitor travel time, traffic flow, etc. Pursue case studies, best practices, synthesis of current practice.
- Public–public–private data acquisition possibilities. Investigate business models that would use the private sector to obtain data for use in the public transportation sector, e.g., many high-tech firms are doing research and development that may have applications.
 - Theme: data outsourcing for data collection from the private sector. Research the various issues associated with using this acquisition approach.
 - Example: use of private freight data within public transport agencies; what are the constraints/hurdles?
 - Example: using cell phones as probes.
 - What are the assurances of quality that are needed, acquisition cycles that are preferred, costs, and what types of new data are possible?
 - Where are public–public joint data collection activities going on? What are the models for a successful joint data collection and use?
 - Review international models
- Cost–benefit analysis for different approaches to integration. Is the great cost of front-end integration through technology worth it versus integrating databases later in the process.

- An inventory of asset management data is going on in FHWA to sum up what is available in the different data sets.
- Horizontal and vertical cross-jurisdictional PM. Research into how to get consistency within states between various jurisdictions and across modes on data collection for PM. What incentives and transition approaches are most conducive to integrating multiple systems that often are at different levels of sophistication? Horizontal and vertical data integration issues include best practices. An investigation may be needed into multiple spatial referencing systems; how to bring the lessons learned into the practices of the transportation agencies.
- How can locally managed signal systems provide information for operations management? Investigate institutional boundaries and successful approaches to overcoming barriers between traffic signal control community and other transportation professionals that use PM data.
- Investigate point of service performance data collection in the field for PM such as clearing snow to dry pavement. Quick response data collection and feedback loops from remote transmission of data.
- Real-time transfer of information to the customer. Best practices and cost-benefit of real-time transfer of information to the customer. What is needed in terms of “real time” to be useful? How quickly can traveler absorb and change choices? Suggest investigation of this topic at the conference. Information should be put forward in a useful toolkit approach for use at an applications level. How can mode-specific PM be used to balance the system and change behavior of users to affect modal use? Is a common information framework possible to influence distribution between modes? For example, information on the availability of parking, to avoid unnecessary travel looking for parking. What information is needed and how to make this available to maximize capacity and spread use between modes.

PRIORITY ISSUES FOR FUTURE RESEARCH

Investigate New Funding Opportunities for Data Acquisition Targeted at Performance Measurement (Related to Theme 1)

Transportation agencies are faced with pressure to deliver large construction projects at a time when project costs are escalating and traditional trust fund revenue streams are weakening. These pressures create a great need to have data that ensures the right investments are being made and that transportation agencies have the best information available for staying accountable to customers. But, unfortunately, budget pressures may force real-time data onto the back burner. This research will investigate how to sustain robust data acquisition and analysis programs by:

- Investigating how states build business cases to develop and sustain data acquisition;
- Exploring what is needed to build an organizational culture that supports data; and
- Researching the linkage between performance measure usage during normal transport use and PM needs during time of emergencies, with an emphasis on exploring whether on-going monitoring programs could be cross-funded by emergency preparedness programs. (Possible conference or synthesis topic: Bob Winick)

Research Performance Measurement for Behavioral Safety Investments (Related to Theme 1)

SAFETEA-LU requires states to develop strategic highway safety plans that include consideration of behavioral as well as infrastructure investments. After its plan is complete, a state may invest a percentage of its highway funding in behavioral strategies as opposed to infrastructure. However, traditional cost–benefit analyses for infrastructure are well established while performance measures to support investment in behavioral strategies are not available to support these investments. This research is desirable to put behavioral safety investments on the same plain as engineering strategies. (Rich Margiotta, Cambridge Systematics)

Need for a New Professional Skill Set (Related to Theme 3)

There is a need for a new professional in transportation agencies—someone who is technically savvy, knows the business processes, and synthesizes the information for real-time application or for use by top executives. This research will explore the institutional models for access to data and information with the recognition that non-specialists (i.e., non-IT analysts) need direct access to data. Products may include a tool kit or a description of a new business skill set. Research will also explore team approaches to data flow from acquisition through decision making in the context of performance oriented transportation agencies and data used to support decision-making. (Research: Aarion Franklin, MTA; Dave Ekern, ITD)

Investigate Public–Public–Private Data Acquisition Possibilities (Related to Theme 4).

This research investigates business models where data is obtained from nontraditional means including mutually beneficial partnerships with the private sector or other public agencies, outsourcing data acquisition, and emerging technologies that may provide transport data. It also will define obstacles to using this data and provide suggested approaches to obtain and use private sector transport data. Specific areas for investigation include:

- Use of private freight data within public transport agencies—what are the constraints/obstacles?
- Using cell phones as probes in the public transportation sector—what are the constraints/obstacles?
- Investigate the opportunities to partner with high-tech firms for transport applications—both research and development and existing applications.
- If legal obstacles exist, research legal approaches that have succeeded and develop a toolkit for public transportation agencies that advances the use of this data acquisition approach.
- Explore agencies that are outsourcing data collection activities. What are their assurances of quality, acquisition cycles, and costs?
- What are the business models for successful joint data collection activities between multiple public agencies or public transportation agencies and the private sector?
- Also, review applicable international models for shared data acquisition and use.

(Research: Jeffrey Short, ATRI; Bob Winick, Motion Maps, LLC)

Research Performance Measurement Data Consistency (Related to Theme 4)

This topic will research data collection consistency and integration issues across jurisdictions and between various data silos within transportation agencies. What incentives and approaches are most conducive to integrating multiple systems that often are at different levels of sophistication? This topic includes a best practices investigation into multiple spatial referencing systems with an emphasis on how to bring the lessons learned into the practices of the transportation agencies. (Research: Linda Cherrington, TTI)

Real-Time Transfer of Information to the Customer (Related to Theme 4)

This research explores best practices and the cost–benefit of real-time transfer of information to the customer. Specifically, what information is needed and how to make it available to the customer in a useful framework that will spread use between modes and maximize system capacity? What is needed in terms of real time to be useful? How quickly can travelers absorb and change choices? How can mode-specific PM be used to balance the system and change behavior of users to affect modal use? For example, information on limited parking availability has been shown to reduce travel by eliminating searches by drivers. Information should be put forward in a useful toolkit approach for use at an applications level. (Rich Margiotta, Cambridge; Linda Cherrington, TTI)

RESEARCH PROBLEM STATEMENTS

Developing Performance-Based Investment Programs and Data Systems

RANDY HALVORSON

Minnesota Department of Transportation

This proposal was generated by the Challenges of Data for Performance Measures Workshop held on July 8, 2006. The concept was to bring both performance measures and data professionals together to share experiences and identify key issues relating to the data sources used to support performance measures. A total of 25 state and MPO representatives participated in active discussion groups, along with 13 others. This proposal was ranked No. 1 in importance by the workshop planning committee that was led by Randy Halvorson of Minnesota DOT.

DEVELOPING PERFORMANCE-BASED INVESTMENT PROGRAMS AND DATA SYSTEMS

Problem Statement

Transportation organizations are asking for detailed guidance on how to institutionalize planning, programming and investment decision-making processes based on performance data. What are the key steps, tools and processes to build this system? A related problem is that data needed for decision making often has gaps, lacks standardization within and across organizations, is segregated in silos such as legacy systems, or has other limitations.

Some transportation organizations have solved many of these challenges and are a source for best practices. Research needs to acknowledge that there may be multiple approaches to successful processes and best practices, reflecting differences in organizations and jurisdictions.

NCHRP Report 551: Performance Measures and Targets for Transportation Asset Management (p. 43), provides a good description of the information and analytic tools needed to support a performance-based program, but notes that while several types of performance-based management systems (pavement, bridges) have been successfully used by DOTs, their use in policy, program, and executive level decision making is limited. This is at least partly due to issues related to data quality, availability, systems integration, and tools to retrieve data, analyze it, develop predictive models, conduct tradeoff analysis, and report results in useful formats.

Research Objective

The objective of the research is to develop guidance for institutionalizing performance-based investment decision making and supporting data systems. It will identify successful approaches using an organizational and systems development perspective. The study products will include but not be limited to the following elements:

- What are the key elements of a performance-based investment process?
- What are the tools and systems needed to develop and implement performance-based decision making?
 - What data systems and tools are needed to make decisions among competing investment targets and across partnering organizations?
 - What are the key technical considerations to guide data tool and data system development?
 - What are the key concepts to guide agency organization, roles, and responsibilities for various units in developing data tools and systems and in implementing data tools and systems?
 - Flow charts showing alternative methods for data organization and data flow through a performance-based program to illustrate how system components fit and work together, and how data is processed
 - Examples of data reports to illustrate alternative methods for presentation of information, with explanation of how each report is or might be used
 - How is a plan developed for data collection, data documentation, storage, analysis, and reporting to support measures?
 - What types of uniform data standards are required? How can uniformity of measures and data across state and local governments be achieved?
 - Can alignment with performance data needs contribute to building stronger data systems?
 - How do planning, data, and performance management areas partner with IT?
 - How are performance-based systems used? (To make decisions, to track trends, to share with the public, to satisfy a legislative mandate, etc.)

RELATED WORK

NCHRP Report 551: Performance Measures and Targets for Transportation Asset Management.

Transportation Research Board of the National Academies, Washington, D.C., 2006.

Effective Organization of Performance Measurement. NCHRP 8-36, Task 47 Report.

Issues and Challenges in Using Data and Tools for Performance Measurement. *Conference Proceedings 36: Performance Measures to Improve Transportation Systems: Summary of the Second National Conference.* Transportation Research Board of the National Academies, Washington, D.C., 2006, p. 131.

Transportation Data and Performance Measurement. In *Conference Proceedings 36: Performance Measures to Improve Transportation Systems: Summary of the Second National Conference.* Transportation Research Board of the National Academies, Washington, D.C., 2006, p. 75.

URGENCY AND PRIORITY

This proposal was generated by the Challenges of Data for Performance Measures Workshop held on July 8, 2006. The concept was to bring both performance measures and data professionals together to share experiences and identify key issues relating to the data sources used to support performance measures. A total of 25 state and MPO representatives participated in active discussion groups, along with 13 others. This

proposal was ranked first in importance by the workshop planning committee that was led by Randy Halvorson of Minnesota DOT.

User Community

State agencies, MPOs, local government, FHWA, AASHTO, APTA, transit providers.

Implementation

Identified best practices will serve as a guide for the user community developing and implementing performance-based decision processes.

Effectiveness

Success will be achieved when the best practices are implemented by the user community. These practices will enhance the precision of investment decision making.

Cost

\$325,000

RESEARCH PROBLEM STATEMENTS

Setting Effective Performance Targets for Transportation Programs, Plans, and Policy

ROLF SCHMITT

Federal Highway Administration

This proposal was generated by the Challenges of Data for Performance Measures Workshop held on July 8, 2006. The concept was to bring both performance measures and data professionals together to share experiences and identify key issues relating to the data sources used to support performance measures. A total of 25 state and MPO representatives participated in active discussion groups, along with 13 others. This proposal was ranked No. 2 in importance by the workshop planning committee that was led by Randy Halvorson of Minnesota DOT.

PROBLEM STATEMENT

Transportation agencies at all levels of government are embracing PM to guide operations, asset management, capital investments, and policy development. While an extensive and growing literature exists on defining and applying performance measures, little attention is given to methods for setting performance targets. Most agencies appear to base performance targets on arbitrary standards or marginal adjustments to trends. If performance targets are set without a sound and defensible basis, the effectiveness of PM as a management tool to improve efficiency and accountability can be compromised.

NCHRP Report 551: Performance Measures and Targets for Transportation Asset Management outlines basic steps for setting targets; however, the methods described in the report for setting performance targets are limited primarily to asset preservation. Development of a wider ranging and more rigorous set of methods to establish performance targets are required to support effective management and accountability for all aspects of transportation, from planning and policy development to project implementation and operations.

RESEARCH OBJECTIVE

The objective of this research is to develop a comprehensive, rigorous set of methods for establishing performance targets to support effective management and accountability for all aspects of transportation. Candidate methods should be drawn from within and beyond the transportation sector, and should include methods used by public agencies and private organizations. Methods can be based on benefit-cost analyses, peer comparisons, industry standards, and other means. Study products will include:

- State-of-the-practice review of methods used by federal, state, and local agencies, non-profit groups, and related organizations in the United States and other countries for setting

performance targets in transportation policy, planning, program development and implementation, project development and implementation, and operations.

- State-of-the-practice review of methods used by carriers, shippers, private investors in transportation, and other transportation and transportation-related businesses for setting performance targets, and an assessment of applicability of the methods to transportation agencies.
- State-of-the-art review of methods for setting performance targets in areas outside of transportation (such as social services and manufacturing), and an assessment of applicability of the methods to transportation agencies.
- Examination of the role of forecasting, causation versus symptoms, and outputs versus outcomes in setting performance targets.
- Examination of data precision considerations in setting performance targets.
- Examination of ways in which benefit–cost analysis can be applied to setting performance targets, and implications for research and data to improve benefit-cost analysis.
- Examination of methods for setting multiple targets among related or competing performance measures.
- Examination of the role of public expectations, experimentation, and accountability in encouraging innovation and establishing “stretch” targets.
- Assessment of the effectiveness of existing and emerging methods from within and beyond the transportation sector for setting performance targets in transportation policy, planning, program development and implementation, project development and implementation, and operations.
- Proposed set of methods and associated data requirements for setting performance targets for transportation policy, planning, program development and implementation, project development and implementation, and operations.
- Case studies of applications of the proposed methods for setting performance targets (potentially one case study in safety and one in capital project delivery).
- Summary report on methods for setting effective performance targets for transportation policy, plans, programs, projects, and operations (including theory, practical considerations, and case studies).
- Guidebook for Setting Effective Performance Targets for Transportation Policy, Plans, Programs, Projects, and Operations.
- Additional training materials to support the guidebook.

RELATED WORK

NCHRP Report 551: Performance Measures and Targets for Transportation Asset Management.
Transportation Research Board of the National Academies, Washington, D.C., 2006.

While extensive literature exists on definition and use of performance measures, treatment of methods for setting performance targets is very limited.

URGENCY AND PRIORITY

This study has a very high priority for agencies that are implementing PM throughout their organization. The success of performance-based management is greatly enhanced by credible, understandable targets that are feasible to achieve and that stretch performance. The use of arbitrary targets without a sound basis encourages the treatment of PM as a needless burden rather than as the key to improving the efficiency and effectiveness of transportation facilities and services. This study will provide the sound basis for setting performance targets.

COST

\$375,000. This assumes approximately \$250,000 for the research and development phase and \$125,000 for case studies and development of the guidebook and other training materials. The study is estimated to take 18 to 24 months to complete.

USER COMMUNITY

The primary audience of this study includes senior program managers, planners, and administrators in transportation agencies at the federal, state, metropolitan, and local levels who are responsible for assuring effectiveness, efficiency, and accountability of policies, plans, programs, and projects.

IMPLEMENTATION

The guidebook and additional training materials from this study will be designed for use in management courses sponsored by USDOT, AASHTO, and others.

EFFECTIVENESS

This study will be successful if more understandable and credible methods for setting performance targets are adopted by transportation agencies at all levels of government. The study will be highly successful if the adopted methods encourage greater consistency of performance goals and targets among policies, plans, program development and implementation, project development and implementation, and operations.

RESEARCH PROBLEM STATEMENTS

Integrating Individual Transportation System-Level Performance Programs to Determine Network Performance

DEBBIE MAH

California Department of Transportation

This proposal was generated by the Challenges of Data for Performance Measures Workshop held on July 8, 2006. The concept was to bring both performance measures and data professionals together to share experiences and identify key issues relating to the data sources used to support performance measures. A total of 25 state and MPO representatives participated in active discussion groups, along with 13 others. This proposal was ranked No. 3 in importance by the workshop planning committee that was led by Randy Halvorson of Minnesota DOT.

PROBLEM

Governmental entities at all levels are currently involved in the process of developing and reporting results of programs aimed at measuring transportation system performance. To date, research in this arena has primarily focused on establishing general frameworks and guidelines to serve as a basis from which system-level performance programs may be established and expanded. Such research provides examples of the tools and institutional frameworks that are necessary for the construction of PM programs designed to measure the performance of individual transportation systems. What is missing from the literature is an understanding of the performance of transportation networks (a combination of transportation systems representing multiple modes and jurisdictional ownership) that function across political and institutional boundaries. Whether individual systems are owned, operated and maintained by state, regional or local governments, specially designated authorities, or the private sector, it is expected that users will be able to navigate among the systems with relatively little knowledge of the controlling entity. This is at the heart of creating a “seamless” transportation network that, in one form or another, is a primary goal of most, if not all, transportation providers throughout the US. Performance evaluation of individual systems alone is not sufficient to determine multimodal and multijurisdictional network performance. What is needed is in-depth analysis of the potential for integration of PM programs that have been created to gauge the performance of individual systems, to measure the performance of multimodal and multijurisdictional transportation networks. Once an understanding of network performance is gained, results can be used to inform and improve decisions related to not only the process by which projects are selected and implemented by transportation professionals and other decision makers, but also to the usefulness of the transportation network to all users.

Such research will build on existing research, providing necessary insight into implementation by not only identifying system-related PM program commonalities and dissimilarities, but also by identifying ways in which existing multimodal and multijurisdictional performance programs may be integrated to provide estimates of transportation network

performance to improve decisions and thereby improve the flow of people and goods along the network.

OBJECTIVE

The objective of this proposal is to assist transportation professionals as they strive to implement performance management programs by investigating how individual, multimodal, multijurisdictional, system-level PM programs can be integrated to provide estimates of transportation network performance.

The final product should outline the process of integrating multimodal and multijurisdictional performance programs using information from a representative sample of state, regional, and local programs. Information considered for analysis should include an understanding of individual system priorities, goals, and associated data sources, methods of analysis and procedures for implementing program results at both the system and network levels to improve network-related decisions.

RELATED WORK

The majority of research for developing transportation system performance management programs highlights the tools, frameworks, guidelines necessary for performance program creation and implementation. No investigation exists of the potential for integration of system-level PM programs to measure the performance of multimodal and multijurisdictional transportation networks.

URGENCY AND PRIORITY

Scarce transportation resources and the need for improved decision support tools are two main justifications for the development of performance management programs. The main justification for this research is that although many jurisdictions have begun the process of creating PM programs, few, if any, have attempted the comprehensive, multijurisdictional implementation of performance management programs required for the strategic planning of transportation networks. While many are knowledgeable concerning individual, system-level performance programs—their creation and implementation, many have yet to attempt multijurisdictional, network-level performance program creation or implementation.

Implementation and integration of transportation system performance management programs is essential if public transportation providers are to make the transition to more business-like operations. Without the comprehensive, multijurisdictional integration of PM program monitoring efforts and results, the network impacts of system-level decisions will remain unclear and largely unpredictable. Thus the ultimate impact of decisions made will be imprecise resulting in varying chances of success or failure.

It is impossible to make decisions among multiple investments without an overall understanding of possible options and outcomes. The knowledge gained through this in-depth research project will result in network-level PM providing such understanding by carefully laying

out the multitude of factors and their affect on the provision of a seamless transportation service that all providers of multimodal, multijurisdictional transportation systems strive to provide for their customers.

COST

\$300,000

USER COMMUNITY

State agencies, AASHTO, APTA, FHWA, MPOs, transit providers.

IMPLEMENTATION

Research would lead to the evaluation of transportation network performance, results of which could then be included in transportation network-related decision-making processes in addition to regional and statewide performance evaluations. Results would also be available for integration into state and regional transportation plans and other planning and programming documents.

EFFECTIVENESS

Ultimate effectiveness could be determined by

1. The level of interest and interagency cooperation resulting from integration efforts (a result that could have far-reaching impacts on many issues with multiagency interest), and
2. The development of multimodal, multijurisdictional, network-level performance evaluations.

Successful research could lead to improved planning, decision-making and strategic investment of funding by estimating the performance of transportation networks rather than individual systems as with many current efforts.

RESEARCH PROBLEM STATEMENTS

Real-Time Transfer of Information to the Customer

LINDA CHERRINGTON

Texas Transportation Institute

This proposal was generated by the Challenges of Data for Performance Measures Workshop held on July 8, 2006. The concept was to bring both performance measures and data professionals together to share experiences and identify key issues relating to the data sources used to support performance measures. A total of 25 state and MPO representatives participated in active discussion groups, along with 13 others. This proposal was ranked No. 4 in importance by the workshop planning committee that was led by Randy Halvorson of Minnesota DOT.

PROBLEM

- Transportation agencies have the ability to collect considerable data about how a transportation facility is performing. As technology becomes more and more sophisticated, transportation agencies have the ability to make real-time performance data available to the customer. Research is needed to determine costs and benefits of real-time transfer of performance data to the customer.
- Specifically, research is needed to determine the effectiveness of real-time data to influence travel decisions of individuals, passenger transportation service providers, and freight haulers. This research is especially important for influences on travel among regions and states to support the development of effective data exchanges among states under section 1201 of SAFETEA-LU.

OBJECTIVES

- Research the best practices and cost–benefit of real-time transfer of performance data to the customer.
- Document the success of real-time data as influence on individual travelers to adjust travel patterns based on the availability of data.
- Determine what information is needed and how to make it available to the customer in a useful framework that will contribute to the spread of demand between modes to optimize system capacity.
- Research how quickly travelers can absorb and change choices.

RELATED WORK

NCHRP IDEA—Innovations Deserving Exploratory Analysis. NCHRP and TCRP have a number of ongoing research projects focused on the best use of performance data to improve system efficiency and maximize capacity. FHWA and FTA sponsor the Transportation Planning Capacity Building Program

URGENCY AND PRIORITY

- As financial resources to expand transportation infrastructure capacity diminish, the ability to use data and technology to maximize capacity is critically important.
- SAFETEA-LU requires within 2 years of enactment the establishment of data exchange formats to ensure that the data provided by highway and transit monitoring systems, including statewide incident reporting systems, can be readily exchanged to facilitate nationwide availability of information. Data exchange formats should be based on the types of information deemed useful to interstate travelers and this important to share.

COST

Estimate cost for the research \$225,000

USER COMMUNITY

The primary audiences for this research are the chief operating officers and IT managers for transportation agencies.

IMPLEMENTATION

Information needs to be put forward in a useful toolkit approach for use at an applications level.

EFFECTIVENESS

This research can help determine how to use data and technology to provide information to the customer that may influence travel behavior.

APPENDIX

Acronyms

AADT	annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADOT&PF	Alaska Department of Transportation and Public Facilities
APC	automated passenger counting
ATP	area transportation partnership
AVL	automated vehicle location
BI	business intelligence
BMS	bridge management system
BPI	business process improvement
CADD	computer-aided design and drafting
Caltrans	California Department of Transportation
CHP	California Highway Patrol
CMAQ	Congestion Mitigation and Air Quality
DMS	document management system
DOT	Department of Transportation
DUI	driving under the influence
EMS	emergency medical services
FARS	Fatal Accident Reporting System
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FTP	Florida Transportation Plan
GIS	geographic information system
GMAP	Washington State Government Management, Accountability and Performance Program
HAS	Highway Analysis System
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Plan
IMMS	Caltrans Integrated Maintenance Management System
ICAT	Integrated Corridor Analysis Tool
IHSDM	Interactive Highway Safety Design Model
IRC	interregional corridors
IRI	International Roughness Index
IT	information technology
ITD	Idaho Transportation Department
ITS	intelligent transportation systems
KDOT	Kansas Department of Transportation
LDM	Minnesota DOT Location Data Manager
LRS	linear referencing system
MDOT	Montana Department of Transportation

MIRE	Minimum Inventory of Roadway Elements
MMS	maintenance management system
MOU	memorandum of understanding
MPO	metropolitan planning organization
MTC	Metropolitan Transportation Commission
NATMEC	North American Travel Monitoring Exhibition and Conference
NBI	National Bridge Inventory
NPTS	Nationwide Personal Transportation Survey
NTOC	National Transportation Operations Coalition
OMB	Office of Management and Budget
OTDA	Minnesota DOT Office of Transportation Data Analysis
OWP	Overall Work Program
P3	MDOT Performance Programming Process
PeMS	Performance Monitoring System
PL	Federal Planning Funds
PM	performance measurement
PMCS	Caltrans Project Management Control System
PMIS	SANDAG Performance Monitoring Information System
PMS	Pavement Management System
PPMS	Minnesota DOT Project Management System
RCP	regional comprehensive plan
RDC	regional development commission
ROI	return on investment
RTMC	Minnesota DOT Regional Transportation Management Center
RWIS	road weather information system
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SANDAG	San Diego Association of Governments
SEA	systems engineering analysis
SEP	systems engineering process
SHI	Caltrans State Highway Inventory
SHSP	Strategic Highway Safety Plan
SPR	Statewide Planning and Research
SRC	short range component
STIP	State Transportation Improvement Program
SQL	structured query language
TASAS	Caltrans Traffic Accident Safety Analysis System
TIB	Washington State Transportation Improvement Board
TIS	Minnesota DOT Transportation Information System
TMA	transportation management area
TSN	Caltrans Transportation System Network
TTI	Texas Transportation Institute
VDOT	Virginia Department of Transportation
VOIS	Virginia Operations Information System

WIM	weigh-in-motion
WMS	Minnesota DOT Work Management System
WSDOT	Washington State Department of Transportation
WTI	Western Transportation Institute
XML	extensible markup language

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