Performance Measurement Guidance

LEVEL 2 TO LEVEL 3

Why Performance Measurement is Important

The inclusion of outcome measures, linked to output measures, is a major advancement in operations performance measurement. At this stage, it is possible to track the “bottom line”, the effect that operations strategies have on users’ experiences. However, outcome measures are subject to a variety of influences outside the influence of agency TSM&O.

Improvement Target

<table>
<thead>
<tr>
<th>From</th>
<th>TSM&amp;O strategies measurement largely via outputs, with limited after-action analysis (L2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To</td>
<td>Outcome measures identified and consistently used for TSM&amp;O strategies improvement (L3)</td>
</tr>
<tr>
<td>By</td>
<td>Developing data collection and management plan to support utilization of outcome performance measures</td>
</tr>
</tbody>
</table>

Key Sub-dimensions

- Measures Definition Action Plan
- Data Acquisition Action Plan
- Measures Utilization Action Plan
Measures Definition Action Plan (L2 to L3)

Strategy Summary

Identify limited number of outcome measures, in addition to the output measures defined in Level 2, for use statewide and for national reporting.

Key Actions

A. Review state, local and regional (MPO/RTPA) policy and plans to identify relevant performance measures to determine appropriate range of mission- and customer-related performance measures for operations.

B. Consider both agency and system measures related to a full range of measures for mobility/safety/livability/sustainability.

C. Identify and establish policy accountability and reporting (internal and external) for systems operational performance.

D. Develop outreach program to report measured performance.

ACTIONS

Action A: Review state, local and regional (MPO/RTPA) policy and plans to identify relevant performance measures to determine appropriate range of mission- and customer-related performance measures for operations.

Rationale: Outcome measures that may be important will span different functions within the agency, and among collaborating agencies, because many different groups are concerned with congestion, mobility, safety, and environmental performance. Customer satisfaction measures are also important and can be used in conjunction with outcome measures.

A.1 Review agency’s existing formal mission commitments and relate them to potentially appropriate performance measures. Special attention should be paid to objectives relating to travel time, delay and reliability.

A.2 Review congestion-based performance measures in use in other areas and the data or models that are used to develop them.

A.3 Review measures used in related programs (safety, air quality, economic development) for potential issues and measures overlap. For example, safety personnel will have developed crash-related measures that are relevant for incident and work zone management. Air quality personnel will have developed measures whose development can be improved through the use of operations data.
A.4 Compare local performance issues with national approaches to capitalize on peer experience. Areas to consider include measures’ short list, data collection, and analysis issues, with special attention on travel time and reliability, as well as related computational approaches (see National Transportation Operations Coalition [NTOC] measures as representative of a broad national consensus and focus on how users experience travel time). Review federal guidelines in the area of performance measurement to ensure consistency and for additional guidance.

A.5 Consider measures for different purposes such as planning, strategy improvements, internal accountability and public reporting regarding both temporal and spatial extent of congestion, reliability, and the duration and location of incidents and work zones.

A.6 Consider customer satisfaction measures (in addition to outcome measures) related to quality of service (e.g. how congestion is perceived by users) as opposed to “hard” measures (e.g. average speed in a corridor).

A.7 Congestion measures need to be developed based on three dimensions: temporal, spatial, and source of congestion.
   - Temporal – decide on the time slices for which congestion will be reported. For example: peak hour, peak period, off-peak, weekend/holiday.
   - Spatial – decide over what geographic areas the data will be summarized: segment, corridor, subarea, area-wide.
   - Source of congestion – to the extent possible, “tag” what the contributors to total congestion are: recurring vs. nonrecurring is the easiest break-down. If data and methods permit, decompose nonrecurring congestion into the type of disruption: incidents, work zones, inclement weather, etc.

A.8 Integrate output and outcome measures into a comprehensive performance management program for operations. To the extent possible, determine what effect changes in output measures have on outcome measures. For example, how does a reduction in crash frequency or incident response time change travel times/speeds in a corridor and a region? These linkages can be developed over time if the agency has established a routine evaluation program of operations strategies (discussed in Action D below).

Responsibility and Relationships: Staffing should come from the central office. These Actions require strong communication with other units in the agency to coordinate the measures (e.g., statewide and regional planning); other units may possess the data required for certain types of operations performance measures (e.g. work zone crashes).

**Action B:** Consider both agency and system measures related to a full range of measures for mobility/safety/livability/sustainability
Rationale: At this stage of development, the focus is on developing output performance measures for operations. However, it must be kept in mind for future development that operational strategies affect not only congestion but a range of other impact areas.

B.1 Consider objectives beyond mobility and safety that—based on agency mission and goals, as well as current external policy context (land use, livability, climate change)—may influence the performance measures strategy. For example, consider the following chain of events: A change in policy reduces incident duration, which reduces overall congestion. It also reduces secondary crashes because incident exposure is reduced. Reduced congestion in turn has a positive effect on emissions, and generally influences economic development. Operations performance must be viewed within a larger context that influences an agency’s customers. Operations performance is only part of an overall mobility picture, which includes other modes as well. Mobility, in turn, is part of a larger system of economic activity, which ultimately factors into the quality of life for the public.

Responsibility and Relationships: An existing Architecture Task Force may be used to include relevant participants, both internal and external. In addition, state and regional planning staff should be involved to provide relationships to state and regional policy.

Action C: Identify and establish policy accountability and reporting (internal and external) for systems operational performance

Rationale: While some measures may be dictated by legislative or regulatory mandates, it is also useful to select measures that provide internal or detailed operational and planning data beyond that normally required for reporting purposes.

C.1 Review internal performance accountability structure, including both program and unit performance for management purposes. Identify existing or proposed reporting, review processes, and identify the information, format, frequency and media used for reporting.

C.2 Review the value of performance outcome information with planning units (state, local MPO/RTPA) and establish arrangements for transfer of information as appropriate for use in upgrading deficiency analysis and travel forecasting. At the MPO level, this involves close coordination with the Congestion Management Process, since a key component is the ongoing monitoring of system conditions.

C.3 Review external performance accountability structure and key audiences, including reporting regulations, requirements of policy/decision makers, and potential voluntary reporting (as per agency dashboards, briefings and other reports). Consider key audiences including: other transportation agencies (coordination, support, reporting), elected officials (funding and leadership), business community (coordination with development), private sector service providers (data and services provision), academia (research), and the general public.

C.4 Evaluate existing accountability scheme on a regular basis to identify improvements that can be identified in the measures, data, actions, and communication devices.
Responsibility and Relationships: The policy on accountability must be sponsored by top management and can be developed by operations staff in the central office. Note that operations accountability has parallels in other types of program and project accountability and must be coordinated on a multi-program basis.

Action D: Develop outreach program to report measured performance

Rationale: Agency TSM&O program understanding and support can be affected by demonstration of its relevance to policy makers and user-customers. It is useful to revisit the selected measures and compare them to possible improvements that may be evaluated for uses and audiences.

D.1 Relate performance measures to known customer interests (and vice versa) and determine if measures illustrate the effect of the improvements that communicates in an understandable and reliable way to the customers. A wide variety of customers must be considered:

- Accountability – elected officials and the public are a major customer base
- Agency management must be informed of the effectiveness of operations programs to build internal support
- Agency personnel responsible for programming annual budgets need to have concise information on how operations affects system conditions – this is needed in order to build the case for operations budgets
- Agency and non-agency personnel responsible for performance management of their own will benefit from coordination with operations performance activities – this includes those in the agency responsible for meeting MAP-21 performance requirements, MPOs responsible for their own MAP-21 performance requirements as well as the Congestion Management Process, and non-transportation agencies such as emergency responders with their own performance management needs

D.2 Review aspects of the projects, programs, or policies that will not be identified by the measures and consider options for adding measures or other means of communicating performance.

Responsibility and Relationships: Staffing should come from the central office and coordinate with central office staff responsible for other performance reporting (such as dashboards).
Examples/References:

- See reporting examples in: [http://ops.fhwa.dot.gov/perf_measurement/index.htm](http://ops.fhwa.dot.gov/perf_measurement/index.htm)
Data Acquisition Action Plan (L2 to L3)

Strategy Summary

Develop a data collection and management business plan for collection, integration, management, reporting and application of measures

Key Actions

A  Establish data acquisition plan and system for acquiring outcome data using indirect measurements and analytic methods

B  Identify opportunities for multipurpose data acquisition to service operations, safety, planning, and freight, including external data sources and private provision opportunities

C  Identify opportunities for acquisition of private data

ACTIONS

Action A: Establish data acquisition plan and system for acquiring outcome data using indirect measurements and analytic methods

Rationale: The collection, analysis, storage and retrieval of data must be carefully considered to accommodate efficiency and also use relevance. Travel time is a key measure, so acquiring travel time data is at the center of this activity owing to its direct relevance to customer-related performance interests. It is assumed that direct and continuous measurement of travel times is not feasible at this level, so the use of indirect methods is indicated. This can include: (1) models based on surrogate measures such as volume-to-capacity ratio or (2) use of ITS detectors on freeways where adequate coverage exists (see below).

A.1  Review with staff and management the importance of travel time data—travel times are the basis for all congestion/mobility performance metrics, especially reliability metrics.

A.2  Develop plan to acquire data for travel time measures to support congestion/mobility evaluation. A variety of methods can be used to collect or develop travel times. Travel times can be estimated directly by measuring the passage of individual vehicles over time, synthesized from point detection of spot speeds, or computed with models. Because there is no universal coverage of a single method in urban areas, it is likely that multiple methods will be used in the foreseeable future. The best way is to measure travel times directly via probe vehicles or other instrumented vehicles; these measure the passage of the vehicle over time and space. Indirect methods also exist to develop travel times. Speed data from ITS roadway equipment is commonly transformed to travel times; such estimates have been found to be accurate when detector spacing is reasonably short (<= 1 mile spacing). Models can also be used to transform volumes and capacities to travel times, but such methods usually only consider recurring congestion.
A.3 Review available options for direct measurement of travel time, including probe vehicles or the "floating car" method. Recognize the limitations of both approaches—the availability of probe data and the small sample size uncertainty of floating car approach.

A.4 Incorporate activities to continue and/or augment travel time data with direct volume measures necessary for a full suite of performance measures. Without corresponding volume measurements, data from a sample of probe vehicles (for example) can only be used to compute unit statistics, such as delay per vehicle.

A.5 Consider indirect measures of measurement/modeling as an interim stage such as ITS-detected spot speed conversion, volume-based approaches, and forecasting models.

A.6 Develop a staged approach based on the data that are currently available and consider approaches to filling the gaps indicated.

Responsibility and Relationships: Relevant data may not all be collected by operations personnel. Other units within the agency may also collect useful data (e.g. work zone safety) as well as external organizations (e.g., weather). Staffing should come from the central office.

Action B: Identify opportunities for multipurpose data acquisition to service operations, safety, planning, and freight, including external data sources and private provision opportunities

Rationale: Data collected for operation (real time and archived) can serve not only the needs of operations personnel but a variety of other agency functions.

B.1 Identify other potential users of performance-related data or measures developed for TSM&O. For example, data from roadway detectors can be used to develop a wide array of planning data such as AADT, K- and D-factors, and temporal distributions. The information can also be used to support modeling efforts. Incident data can be used as a supplement to traditional crash data, especially for estimating unreported crashes.

B.2 Consult with other agency units to determine needs and potential overlaps. Consider cost-sharing approaches to satisfy broadest range of needs. For example, the traditional traffic monitoring group may want to use ITS detectors in lieu of temporary counts on congested urban freeways.

B.3 If data purchases from private vendors are being considered, it is imperative that multiple data uses within the agency be identified as a way to justify the expense.

Responsibility and Relationships: Staffing should come from the central office working with stakeholders for the data from non-operations units.
Action C: Identify opportunities for acquisition of private data

Rationale: Private vendors are increasingly developing probe-based databases on a real time basis over increasingly large components of the highway network and are making information available to transportation agencies on a commercial basis.

C.1 Investigate vendor activities within the agency’s jurisdiction to determine current coverage and their ability to expand coverage and the types of data under contract. These vendors assemble travel times collected from vehicle probes for resale in the traveler information market, both public and private.

C.2 Review desired coverage, especially off-freeway (where ITS detection may not exist), for purposes such as 511, diversion and integrated corridor management.

C.3 Develop an integration plan for merging probe data with volume data. For the immediate future, private vendor probe data is only a sample of vehicles in the traffic stream, so some important measures (e.g., delay, VMT) cannot be produced from private vendor data alone.

C.4 Evaluate how existing agency congestion measurement data can be used in conjunction with probe data. For example, if agency detector data is to be used on one part of the network, agencies should understand how such measurements compare to congestion estimates derived from probe data. This will require that an agency perform a test on facilities where both detector and private vendor data are available, and compare the results. If one method produces consistently different results, it is important to understand why this is occurring. At a minimum, reports should include caveats for comparing the performance of facilities with different base data. Note: this problem should not affect trend analysis on individual facilities.

C.5 Compare the performance of private vendor data with agency data specifications and compare pros and cons of outsourcing data collection. Factors to consider include cost, coverage, reliability, data quality, timeframe of availability, and risk of external dependence (with related contingency plan needed).

C.6 Consider a pilot program using private vendor travel time data on a limited basis (e.g., a small set of highways). The pilot should include all aspects of a full-grown performance measurement system: data processing, measure development, and reporting.

Responsibility and Relationships: Central office staff should contact peer agencies regarding experience with private sector data and work with agency procurement staff.

Examples/References:

- “Establishing Monitoring Programs for Mobility and Travel Time Reliability” (SHRP 2 L02): http://www.trb.org/Main/Blurbs/168765.aspx
• “Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes: Technical Reference” (SHRP 2 L05) provides a “how-to” guide for technical staff to select and calculate the appropriate performance measures to support the development of key planning products, including operations planning: http://www.trb.org/Main/Blurbs/168856.aspx
• A discussion of measures and overlap is at: http://www.ite.org/M&O/ntoc_final_report.pdf
• The I-95 Corridor Coalition has a vehicle probe project for performance data. See: http://www.i95coalition.net/i95/Projects/ProjectDatabase/tabid/120/agentType/View/PropertyID/107/Default.aspx#COVERAGE
Measures Utilization Action Plan (L2 to L3)

Strategy Summary

Develop formal management process that utilizes performance reports to measure the effectiveness of TSM&O strategies

Key Actions

A  Develop consistent internal performance data analysis process including targets and benchmarks

B  Develop process to incorporate operations performance measures into the development of highway projects

C  Coordinate congestion reporting with planning personnel; coordinate incident reporting with safety personnel

D  Improve reporting of performance to include both internal (TSM&O) and external (e.g. planning) personnel and public/decision-maker outreach

ACTIONS

Action A: Develop consistent internal performance data analysis process including targets and benchmarks

Rationale: Consistency in how operations performance measures are developed must be maintained especially if different data and methods are used for different parts of the system, and if corridor performance can be compared and area wide statistics can be developed by combining them.

A.1 Establish a start-up approach for outcome performance measurement. Given the complexity of a new process, consideration should be given to a "no target" approach, i.e. using the changes from time period to time period (for ongoing monitoring and evaluations) and among alternatives to indicate performance: "are things better or worse?"

A.2 Establish a process for setting “hard targets.” Initial hard targets should be those that are considered to be achievable in the short term, based on percentage changes in the baseline over a given time period. This is chiefly a consensus building process with input provided from a number of sources, including professionals and elected officials, and in some cases the public. In doing so, agencies will want to follow a multi-step process. Because performance targets will be arrived at by consensus, several passes through the process will be necessary.

A.3 Examine recent trends in the performance measures being considered for a target. Look at the rate of change and any unusual circumstances that might have influenced the change. This analysis
alone will go a long way toward telling an agency what is achievable, and more importantly, what might be acceptable to the public and elected officials. Extrapolate recent trends to the future. Using models or expert judgment, forecast what the performance measures would be under several scenarios: “do nothing,” “business as usual,” “maintain current conditions,” and “aggressive action” are four such scenarios that can bound the possible outcomes. Along with examining the recent past, this provides additional information to be used in the consensus building process.

A.4 Look at the performance of peers. If information is available nationally or from other agencies individually, it can be used to help determine targets. Even within an area with varying conditions, this is a useful approach. If congestion is light on one freeway, and it is agreed that this condition is desirable, then its performance standard could be used on other freeways in the area. Include non-peers with bigger problems. Consider the case of a small city undergoing rapid growth and the resulting growth in congestion. Examination of the current condition of a larger city in the state or region whose conditions are familiar could reveal an upper bound for a target.

A.5 Drill down into the output (activity-based) measures and estimate what the effect of changes in these low-level performance measures will have on the outcome-based targets. For example, consider a congestion target that states that congestion levels will be held constant over the next 10 years in the face of 2 percent annual traffic growth. Models and examining past performance can be used to make estimates of the overall congestion effect of improving certain activities such as reducing average incident duration by 10 percent over the period, utilizing dynamic message signs within work zones, etc. Develop packages of improvements that in total will produce a desired change in outcomes.

A.6 Consider stretch goals to provide vision, direction, and motivation for agencies. An example of a stretch goal is eliminating all roadway fatalities, as proposed by some European nations. Stretch goals require a level of commitment and funding not widely available for most U.S. public agencies and must be instituted with caution.

A.7 Targets for operations programs should coordinate closely with agency-wide performance targets that are set to meet MAP-21 requirements for the congestion, reliability, safety, and freight performance categories.

Responsibility and Relationships: Staffing should come from the central office. Goals and trends must be established in cooperation with responsible units, including external partners. Performance reports generated for operations use may also be relevant for other parts of the agency, especially if agency-wide performance reporting is mandated.

**Action B:** Develop process to incorporate operations performance measures into the development of highway projects

**Rationale:** Due to an increasingly competitive fiscal environment, DOTs are increasingly asked to rank their TSM&O projects against traditional expansion projects as well as conduct other “value” related exercises. This requirement can put operations and ITS projects at a disadvantage since many
specialists in this arena have limited experience in performing benefit-cost analysis, and many of the established tools available for conducting benefit-cost analysis for traditional infrastructure projects are poorly suited to analyzing the specific performance measures, benefits, and costs associated with operational improvements.

**B.1** Identify staff team to review available options for incorporating operations performance measures into the highway development process. Options include both technical aspects (models, data) and institutional (at what point in the development process should they be considered). This should include systems engineers, travel forecasting and transport economists, and data analysts.

**B.2** "Operations performance measures" should include congestion and safety measures beyond recurring congestion and geometrically-influenced crashes. These include:
- Estimates of nonrecurring delay (all sources) or at a minimum, incident delay
- Estimates of travel time reliability
- Estimates of secondary crashes: those that occur in the presence of an initial crash

**B.3** Review the analytical background used in benefit-cost and other evaluations for competing projects in terms of measures, timeframes, and reliability/validity of data sources to establish the benchmark for comparable analysis. Also consider emerging federal requirements for conducting project evaluations.

**B.4** Review available tools regarding their evaluation focus, data requirements, and complexity of analytics compared to available resources. These include:
- ITS Deployment Analysis System (IDAS)
- Screening Analysis for ITS (SCRITS)
- Surface Transportation Efficiency Analysis Module (STEAM)
- Sketch Planning Analysis Spreadsheet Model (SPASM)
- IMPACTS
- Highway Economic Requirements System (HERS) Operations Preprocessor
- Cal-B/C (Caltrans)
- Traffic Operations Corridor Sketch Planning Methodology (Wisconsin DOT)
- Metropolitan Transportation Commission (MTC – San Francisco Bay Area) Regional Transportation Plan Benefit-Cost spreadsheet (postprocessor)
- MTC Cost to Sustain Traffic Operations Systems spreadsheet tool

**B.5** Select “best fit” option(s) for incorporating operations performance measures into the highway development process, and pilot test for level of effort and comparative credibility of results.

**Responsibility and Relationships:** Top management sponsorship may be necessary to standardize new procedures. Staffing should come from the central office with a Team including systems engineers, travel forecasting and transport economists, and data analysts.
**Action C:** Coordinate congestion reporting with planning personnel; coordinate incident reporting with safety personnel

**Rationale:** The information developed in the performance measurement process represents a good opportunity for cooperation between planning and operations personnel and to improve the credibility of TSM&O investments.

- **C.1** Develop liaison with MPO staff regarding ongoing Congestion Management Process (CMP) based on MPO requirements to develop and report output-related congestion/mobility performance measures. There should be a core set of performance measures, especially outcome measures that are common to both operations needs and the CMP.

- **C.2** Identify and reconcile areas of overlap of performance reporting, such as different performance measures and data acquisition approaches being simultaneously utilized, and develop mutual approach to maximize reporting of measures.

- **C.3** Review the data and reporting done by agency safety units to ensure consistency. Of special interest are the so-called high hazard locations identified by safety personnel. These may be useful for incident management activities, such as concentrating or pre-positioning resources.

- **C.4** Adjust TSM&O performance measurement process as appropriate. This may require the addition or deletion of measures and changes in the way the measures are reported.

**Responsibility and Relationships:** Staffing should come from central office. A combined work effort with safety office and MPO staff will be necessary.

**Action D:** Improve reporting of performance to include both internal (TSM&O) and external (e.g. planning) personnel and public/decision-maker outreach

**Rationale:** The impact of reporting depends substantially on the clarity and regularity of reporting so as to present data in a form that provides a “story” of changes in performance.

- **D.1** Develop reports such as web dashboards, briefings and quarterly performance reports to cover a range of audiences and differing levels of detail as appropriate.

- **D.2** Incorporate measures explanation in easily understood terms accompanied by a short, nontechnical explanation and example of the meaning.

- **D.3** Select reporting frequency related to cycle of demand changes and/or TSM&O program improvements, rather than frequencies driven by the cycle of major capital improvements (annual). Consider monthly, seasonal or quarterly reporting to establish a memorable sequence.
D.4 Develop a written and graphic approach to displays, publications and presentations that establishes a recognizable and continuous look and feel and that can easily be used by various audiences to identify problems. Successful outreach efforts for establishing best practice include:

- Stories – narrative reporting to describe projects and programs in plain language that nontechnical audiences understand
- Data – must be credible and form the basis for stories and measures; data sources should be cited and data quality control should be a part of every step of the process
- Graphics – design of the document and charts and diagrams should not distract from the content; should both answer and ask questions; use maps to connect what readers are familiar with to the data; colors can be used, but the charts should work in black and white as well; clearly label the axes and use pointers rather than legends where possible
- Timing – timely and frequent information
- Software – capable of good formats and graphics
- Targets for measures where they have been determined
- Using continuously-collected data as often as possible
- Measuring the causes of the problems. Congestion, safety and other factors have causal factors – many of them are related. Problems with different causes may have different solutions

D.5 Highlight the use of performance measures in project evaluations: what actually happened after project completion? Begin the development of an ongoing project evaluation program (i.e., before/after studies of completed projects). This can be done only for a small number of projects per year until the process is established. Develop a process for examining the results: why a project worked or why it didn’t. This may require a field audit of the implemented project.

Responsibility and Relationships: This effort must be developed in cooperation with central office program and public affairs units as information is likely to be part of existing activity. Staffing should come from the central office.

Examples/References:

- USDOT Congestion Management site: http://plan4operations.dot.gov/congestion.htm