Guide for Performance Measures in Snow and Ice Control Operations

Committee on Maintenance 2018 Annual Meeting
Guide Objectives

- Present core set of measures for snow and ice control
- Provide insight on developing a performance framework
- Help decision-makers identify adjustments in resources
- Highlight best practices in winter maintenance
- Provide detailed procedures to monitor performance
- Provide approach to identify measures and set targets
- Be flexible and inclusive
Guide Overview

10-step process for snow and ice-control performance measures

Chapter 2: Defining Performance Measures
1. Review Mission and Goals
2. Refine Operational Objectives
3. Identify Performance Measures
4. Develop Analytic Approaches

Chapter 3: Implementing Performance Measures
5. Inventory Current Practice and Gaps
6. Identify Data Sources and Needs

Chapter 4: Using Performance Information
7. Set Targets and Establish Baseline
8. Report Performance

Chapter 5: Reinforcing Performance-Based Management
9. Integrate into Decision Making
10. Evaluate Process and Identify Improvements
Defining Performance Measures (Chapter 2)

Agencies creating a core set of performance measures should note:

- No measure is a perfect representation of the complexity of snow and ice response
- Not all measures important to an agency can be fully controllable by agency’s response
- Starting the process is the first and often the most important step
- Some level of subjectivity in performance measurement cannot be avoided
- Performance measures need to be simple and easily understood
Step 1 - Review Mission and Goals

Review agency’s state mission and goals to determine how they relate to snow and ice control

The following questions help identify key elements in determining goals:

- How critical is snow and ice control to the agency mission?
- Is there a handbook/policy for snow and ice control?
- What is the nature of the jurisdiction that the agency manages?
- What is the public sector role in snow and ice response?
- What type of facilities (e.g. arterials, freeways) does an agency manage?
- What type of operational strategies are in use?
Step 2 – Define Operational Objectives

Develop operational and maintenance objectives to meet/refine goals

Snow and ice-control outcome based objectives are defined in the following seven categories:

1. Level of Service (LOS) during event
2. Travel reliability during event
3. Recovery from event
4. Safety
5. Level of customer satisfaction
6. Efficiency
7. Environmental Stewardship
Step 2 – Operational Objectives

Seven Categories of Operational Objectives for Snow and Ice Control

- **1. Level of Service objective**
- **2. Recovery objective**
- **3. Reliability objective**
- **4. Safety objective**
- **5. Customer Satisfaction objective**
- **6. Efficiency objective**
- **7. Environmental Stewardship objective**
### Step 3 – Identify Performance Measures

Once the objectives are identified, it is possible to link them to performance measures.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Identified Performance Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain Level of Service during event</td>
<td>Percent of time road segments meet agency-defined level of service thresholds during winter storms</td>
</tr>
<tr>
<td>Meet recovery criteria set by agency</td>
<td>Percent of segments meeting time to regain or recover to “acceptable criteria” for agency-defined segments after the end of event</td>
</tr>
<tr>
<td>Meet reliability targets for specific routes</td>
<td>Percent of trips within accepted difference between measured travel time index and “additional expected” travel time index for snow and ice events for selected routes</td>
</tr>
<tr>
<td>Support safe operations of the roadway</td>
<td>Five-Year Rolling Average of Fatalities and Injuries (Number, Rate) during a Winter Season</td>
</tr>
<tr>
<td>Meet customer satisfaction ratings</td>
<td>Customer Satisfaction Ratings for Snow and Ice Response</td>
</tr>
<tr>
<td>Support efficient use of resources to meet operational objectives</td>
<td>Cost of Snow and Ice Control spent to meet an established performance criteria for a given winter severity</td>
</tr>
<tr>
<td>Support environmental stewardship goals by optimizing material use</td>
<td>Agency within “acceptable” difference between expected and actual use of salt and other materials in a season</td>
</tr>
</tbody>
</table>
PM #1 – Level of Service During Event

Measure

- Percent of time identified road segments meet agency-defined level of service thresholds during winter storms

Utility

- Measures agency performance of winter maintenance activities
- Acts as a surrogate for crash risk and to some extent mobility needs
- Used to monitor contractor performance

Calculation

- Monitor the service level threshold throughout the event on available roadways
- Calculate percentage of event duration during which the service level threshold was maintained compared to the chosen threshold for the segment

LOS defined as:

- Qualitative assessment of conditions
- Accumulation-related threshold
- Friction-related threshold
- Travel speed-related threshold

LOS will vary based on:

- Roadway functional class
- Observed severity of event
- Day of week
- Time of day
- Operational Strategies in use (eg. VSL)
PM #2 - Recovery

Measure

- Percent of identified segments meeting time to regain or recover to “acceptable criteria” for agency-defined segments after end of event

Utility

- Assesses winter storm management and response performance
- Supports response decisions and post-event analysis

Calculation

- Amount of time that passes from the end of a winter event until acceptable surface condition exists again (e.g., bare pavement)
- Measure does not apply in the same way across all segments of roadway (i.e., different criteria)

Criteria defined by the agency:

- Acceptable condition
- Performance target
- Roadway segment prioritization
- Storm Severity

Monocounty.ca.gov
PM #3 - Reliability

Measure
- Percent of trips within accepted difference between measured travel time index (TTI) and “additional expected” TTI for snow and ice events

Utility
- Provides a measure of service quality and mobility for travelers for specific trips (on certain corridors and time periods)

Calculation
- Ratio of peak-period travel time to free-flow travel time averaged across urban areas, road sections, and time period weighted by VMT
- Assesses TTI during storms versus pre-specified additional TTI for trips and storm severity levels

TTI determined by:
- Estimated based on expert judgment
- Calculated based on historical data
- Modeled

TTI will vary based on:
- Roadway functional class
- Observed severity of event
- Day of week
- Time of day

Monthly Trends — Travel Time Index

FHWA
PM #4a - Fatalities

Measure

- Five-Year Rolling Average of Number of Fatalities during a Winter Season

Utility

- Allows for seasonal evaluations
- Key input to maintenance and incident management planning
- Helps identify locations in need of safety interventions, technologies, programs, practices, and enforcement

Calculation

- Calculated every winter season and averaged to account for seasonal differences
- Multiple seasons used to normalize for expected variations in crash rates

Data Used:

- Detailed crash records
- Weather event data

Types of Measure:

- Fatal crashes vs. fatalities
- Season vs. winter events
- Rate vs. number

Weather.com
PM #4b - Injuries

Measure

- Five-Year Rolling Average of Number of Serious Injury Crashes during a Winter Season

Utility

- Allows for seasonal evaluations
- Key input to maintenance and incident management planning
- Helps identify locations in need of safety interventions, technologies, programs, practices, and enforcement

Calculation

- Serious injuries are defined by FHWA as “disabling injury” or as “A” on National Safety Council KABCO injury classification scale
- Calculated every winter season and averaged to account for seasonal differences
- Multiple seasons used to normalize for expected variations in crash rates

Data Used:
- Detailed crash records
- Traffic volume data
- Weather event data

Types of Measure:
- Serious injury crashes vs. serious injuries
- Season vs. winter events
- Rate vs. number
PM #5 – Customer Satisfaction

Measure
- Customer satisfaction ratings for snow and ice response

Utility
- Provides support to event response decisions and post-event analysis by allowing agency to see how perception of performance changes amongst customers

Calculation
- Track traveler feedback at regional/statewide level through periodic surveys, focus groups, or other engagement
- Consider severity of event (satisfaction decreases with severity increases)

Data collected by:
- Seasonal survey of customer satisfaction
- Survey after specific events

Clipartix.com
PM #6 – Agency Efficiency

Measure

- Standardized cost of snow and ice control spent to meet an established performance criteria for a given winter severity

Utility

- Helps to assess efficiency of agency spending (by translating usage of resources into cost of winter maintenance operations)

Calculation

- Overall cost is standardized by one or more characteristics of maintained/served area (e.g. lane-miles) and the severity of the event or season
- Cost of Winter Operations (per storm and season) = Output of usage indicators of labor, equipment, material, and other resources

Factors that drive cost:

- Geographic size
- Functional class or roadway and priority segments
- Density of roadways
- Rural versus Urban
- Microclimates and hot spots
- Timing of events
- Number of events
- Intensity of events

Theneworleanstribune.com
PM #7 – Environmental Stewardship

Measure
- Agency within “acceptable” difference between expected and actual use of salt and other materials in a season

Utility
- Assesses amount of materials used in a given storm or season to achieve the agency’s LOS while utilizing only the materials necessary
- Provides winter maintenance managers an overall perspective of how the agency is performing

Calculation
- Modeled or Estimate of “Expected amount of material” usage based on winter severity and response objectives (requires historical data, miles of roadway by functional class, and LOS parameters for particular regions)
- Actual Usage
- Acceptable difference (e.g., +/- 10%) between expected and actual use

Material usage impacted by:
- Storm/Season Severity
- Varying LOS
- Proactive Approaches (e.g., treated salt, anti-icing and pre-wetting)
- Computerized Dispensing Equipment
- Equipment calibration
- Yearly weather patterns

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- Yearly weather patterns
Step 4 - General Approach to Analysis (varies by measure)

1. Identify Data Sources, Criteria, and Thresholds
2. Define Performance Targets
3. Collect Identified Data
4. Conduct Necessary Calculations
5. Compare Findings to Targets
6. Normalize/Aggregate Findings (as needed)
Severity Index

Severity is fundamental to many of the performance measures and used by agencies to classify individual events and the winter season.

### Storm Severity Index (SSI) Elements
- Storm Type
- Temperature
- Precipitation
- Drift
- Wind
- Visibility
- Forward Speed

### Winter Severity Index (WSI) Elements
- Temperature averages and extremes
- Snowfall totals
- Average and highest snow depth
- Duration of winter-weather conditions
- Aggregated value of impact (e.g., economic loss)
- Measured by aggregating, averaging, or normalizing features over the season
Implementing Performance Measures

Review Agency Practices
- Current Capabilities for Performance Measurement
- Distinguishing between Weather and Non-Weather Event Conditions
- Determining LOS Before, During, and After Event
- Tracking Materials, Labor, Fuel Use
- Techniques to Normalize Conditions
- Obtaining Road Condition Reports
- Collecting Weather and Road Weather Observations
- Monitoring Traffic Impacts

Assess Current Gaps

Identify Data Sources and Needs
Step 6 – Identify Data Needs and Sources

Key data elements for collection to estimate performance measures:

- Pavement Surface Condition Status
- Fatal Crash Records
- Injury Crash Records
- Timestamp for Start and/or End of Winter Event
- Timestamp for Observation
- Traffic Volume
- Weather Event Information
- Road Closure Information
- Speed Data
- Customer Satisfaction Levels
- Winter Maintenance Resource Use
- Road Weather Data
- Performance Target or Threshold
- Road Segment Information

1. Established once or at beginning of season
2. Ongoing throughout season
Step 7 – Set Targets and Establish Baseline

Target Setting Methods

- Policy-driven
- Analysis-driven
- Consensus-based
- Customer feedback-based
- Benchmark-based

Importance considerations when target setting:

- Timeframes (short, mid, and long-range targets)
- Targets rarely fit neatly into any one method
-Targets will likely involve a combination of approaches
The report should explain how an agency handles snow and ice control

Examples of current DOT reporting include:

- Posting annual reports online with winter maintenance activities
- Producing fact sheets and other materials with activity information
- Having dedicated, publicly available performance reports (e.g., Minnesota, Wisconsin)
- Developing internal data collection and reporting
- Using dashboards to convey info at a high frequency (e.g., Iowa)
- Using advanced analysis and visualization tools (e.g., RITIS)
Step 9 – Integrate into Decision Making

<table>
<thead>
<tr>
<th>Types of Decisions that Should Be Informed by Performance Measures</th>
<th>Level of Support (high, medium, low, blank- NA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1 - High-Level Decision-Maker</strong></td>
<td>Safety</td>
</tr>
<tr>
<td>1 Making the case for additional investment</td>
<td>H</td>
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<tr>
<td>2 Reporting on the cost effectiveness of current responses</td>
<td>M</td>
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<tr>
<td>3 Gaining public and other decision-makers’ support for program</td>
<td>H</td>
</tr>
<tr>
<td>4 Improving decision-making with respect to budgeting and programming funds</td>
<td></td>
</tr>
<tr>
<td><strong>Level 2 - Statewide/Regional Operations/Maintenance Leads</strong></td>
<td></td>
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<tr>
<td>5 Maintaining adequate winter mobility in the state</td>
<td></td>
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<tr>
<td>6 Supporting better allocation of funds between regions/districts</td>
<td>H</td>
</tr>
<tr>
<td>7 Managing performance of contracted services</td>
<td></td>
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<tr>
<td>8 Optimizing material management (balancing available supply and demand)</td>
<td></td>
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<tr>
<td>9 Minimizing environmental impacts</td>
<td></td>
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<tr>
<td>10 Supporting workforce development</td>
<td></td>
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<tr>
<td>11 Supporting traveler information and emergency declarations</td>
<td></td>
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<tr>
<td>12 Supporting asset equipment maintenance decisions</td>
<td></td>
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<tr>
<td><strong>Level 3 - Field Maintenance Supervisors</strong></td>
<td></td>
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<tr>
<td>13 Supporting strategic decision-making for event preparation and response</td>
<td>H</td>
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<tr>
<td>14 Supporting tactical strategies on where and how to respond</td>
<td>H</td>
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<tr>
<td>15 Improving the ability to relate crew performance to level of service</td>
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<tr>
<td>16 Providing effective feedback to field personnel on their performance</td>
<td>H</td>
</tr>
</tbody>
</table>
Step 10 – Evaluate and Improve

- **Performance measures are not static**
  - Measures should be modified along with mission, goals, objectives, and institutional capabilities
  - Increased capabilities result in more comprehensive measures which result in informed decisions

- **Targets should be regularly assessed and revised**
  - Targets may need to change as agencies progress towards their objectives
  - Re-examine targets annual or biennially to determine how realistic they are
  - Adjustments should be based on agency performance and customer satisfaction

- **Performance improvements can occur each season**
  - Continuously improve agency capabilities in data collection, analysis, and reporting
  - Improve collaboration between fleet operators, managers, and decision makers
  - Invest in data and technology and staff training
Key Recommendations

Use weather "events" as the starting point

• Allows for greater flexibility in the definition of performance measures.
• Consistency across the agency’s jurisdiction is more important than the definition itself.
• Data collection, aggregation and analysis can be tied to specific points in the event timeline (before, during, and after the event ends).

Develop both a “storm severity” and a “seasonal severity” index

• The value of a performance measurement is greatly enhanced by pairing it with severity both at the event and seasonal level.
• The effectiveness of a severity index is simply determined by its degree of correlation with the maintenance response.
Key Recommendations

Pick a consistent LOS and recovery criteria and how it is measured across the agency

- Subjectivity is unavoidable in snow and ice performance measurement.
- There likely is no “correct or universally applicable” LOS or recovery standard nationally.
- Defining how these are measured can be made more consistent within the agency.

Report performance information

- This allows regional and county staff to compare resource use with that of their peers.
- DOTs develop annual performance measurement reports, fact sheets and other publications that provide information about winter storm maintenance activities.
- This type of report gathers data to help agencies identify good performance as well as areas that need improvement.