FHWA Operations Benefit/Cost Analysis Desk Reference Project

FDOT D2 TSM&O Workshop
Anita Vandervalk, PE – Cambridge Systematics
B/C Analysis Agenda

• Project Need/Overview
• Why is B/C Analysis Important for Operations Planning?
• Real World Challenges of B/C for Operations
• Overview of Guidance in the Desk Reference
• Analysis Capabilities of the TOPS-BC Tool
Project Need

• Project was initiated by talking with practitioners about their real-world needs and challenges

• Operations personnel are increasingly being required to conduct B/C, yet many are unfamiliar with the process

• Many Operations strategies require unique analysis that may be taxing to even seasoned B/C analysts
Project Outcomes

- **Desk Reference Document**
  - Provide comprehensive, one-stop-shopping for B/C information related to TSM&O (June 2012)

- **Companion Operations B/C Decision Support Tool**
  - TOPS-BC

- **Workshop/outreach Opportunities**
Why B/C Analysis is important for Operations Planning

• Provides a systematic process for calculating and comparing benefits and costs of a project for two purposes:
  – Determine if the investment is sound
    • Justification
    • Feasibility
  – Compare it with alternate projects
    • Prioritize different operational strategies
    • Compare operational strategies with traditional strategies
B/C Analysis Supports Performance Based Planning

Regional Goals and Motivation

Operations Objectives

M&O Strategies
- Systematic Process to Develop and Select M&O Strategies to Meet Objectives

- Define Performance Measures
- Determine Operations Needs
- Identify M&O Strategies
- Evaluate M&O Strategies
- Select M&O Strategies for the Plan

Metropolitan or Statewide Transportation Plan

Metropolitan or Statewide Transportation Improvement Program or Other Funding Programs

Implementation/System Operations
Practitioners Facing Many Challenges

- Challenges related to applying conventional B/C framework to Operations
  - Current performance measures, available data, analysis tools and cost parameters are not sensitive to unique nature of Operations
- Challenges related to M&O strategies themselves
  - Limited data for new and emerging strategies
  - Assessing non-recurring conditions
  - Effect and value of traveler information
  - Assigning costs for backbone infrastructure
  - Analysis challenges of non-physical improvements
Assessing the Synergistic Benefits of Integration
Weekday Travel Times
5:00-6:00 P.M., on State Route 520 Eastbound, Seattle, WA

- Martin Luther King Day: 1 Incident with Rain
- Presidents Day: 3 Incidents
- Presidents Day: 1 Incident with Rain
- Presidents Day: 4 Incidents
- Incidents with Rain:
  - Jan 3: 2 Incidents with Rain
  - Feb 2: 3 Incidents
  - Mar 4: 1 Incident with Rain
  - Apr 3: 1 Incident

Travel Time (in Minutes)
Guidance Available in the Desk Reference Document

• Report available in June 2012
• Document and other products have evolved as a result of outreach efforts
• B/C analysis primer information
• Definition of Ops strategies and likely impacts
• Available tools/methods and selection criteria
• Strategies for addressing identified challenges of B/C analysis for operations
• Methodologies for assessing travel time reliability
• Discussion of multi-scenario analysis methods
Chapter 2, Overview of B/C Analysis for Operations - Overview of B/C analysis, its role in the planning process, basic terminology and concepts, and identification of general challenges and limitations

Chapter 3, Operations Strategies and Their Impacts - Basic definitions of the types of TSM&O strategies covered in this project and maps strategies to their likely impacts/benefits

Chapter 4, Existing B/C Tools and Methods summarizes the capabilities with the strengths and limitations of many existing B/C tools and methods to aid practitioners in identifying appropriate situations

Chapter 5, Conduct B/C Analysis for Operations - More detailed, step-by-step guidance on how to successfully conduct B/C analysis for operations strategies, identify considerations that need to be made, and highlight challenges that may be encountered
## Typical Benefit and Costs

<table>
<thead>
<tr>
<th>User</th>
<th>Societal</th>
<th>Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>Environmental/emissions</td>
<td>Efficiency</td>
</tr>
<tr>
<td>Travel time reliability</td>
<td>Health</td>
<td>Productivity</td>
</tr>
<tr>
<td>Safety</td>
<td>Mobility</td>
<td>(Costs)</td>
</tr>
<tr>
<td>Vehicle operating costs</td>
<td>Productivity</td>
<td></td>
</tr>
<tr>
<td>Fuel costs</td>
<td>Security</td>
<td></td>
</tr>
<tr>
<td>Comfort/convenience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Costs)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## TSM&O Strategies Covered

<table>
<thead>
<tr>
<th>TSM&amp;O Strategy</th>
<th>Discussed in Desk Reference</th>
<th>TOPS-BC Analysis Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Strategies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arterial Signal Coordination</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Arterial Transit Signal Priority</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Transit Automatic Vehicle Location</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Ramp Metering</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Incident Management</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Pretrip Traveler Information</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>En-route Traveler Information</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Work Zone Management</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>HOT Lanes</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Speed Harmonization</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Hard Shoulder Running</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Travel Demand Management</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
# TSM&O Strategies Covered (continued)

<table>
<thead>
<tr>
<th>TSM&amp;O Strategy</th>
<th>Discussed in Desk Reference</th>
<th>TOPS-BC Analysis Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supporting Strategies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Surveillance</td>
<td>●</td>
<td>$</td>
</tr>
<tr>
<td>Traffic Management Centers</td>
<td>●</td>
<td>$</td>
</tr>
<tr>
<td>Communications</td>
<td>●</td>
<td>$</td>
</tr>
<tr>
<td><strong>Non-physical Strategies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active Transportation and Demand Management (ATDM)</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>System Integration</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Interagency Coordination</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Regional Concepts for Transportation Operations</td>
<td>●</td>
<td></td>
</tr>
</tbody>
</table>
• Requirements
  – Macro-driven spreadsheet environment
  – Designed to be intuitive to use
  – Default figures (based on real-world data) are documented and understandable
  – Formulas are reviewable
  – Easy maintenance and customization

• Four Key Capabilities…
TOPS-BC - Tool Options

What would you like to do today?

1. Investigate the Range of Expected Values Associated with Various TSM&O Strategies

2. Map Different Benefit/Cost Methodologies to Your Organization's Needs

3. Estimate Lifecycle Costs of TSM&O Strategies

4. Conduct Simple Spreadsheet-Based Benefit/Cost Analysis for Selected TSM&O Strategies
TOPS-BC: 1) Investigate Impacts

Investigate the Range of Impact Values Associated with Various TSM&O Strategies

Navigation Screen

Instructions: Please select the "TSM&O Strategy" and the "Impact Category" you are interested in from the list below. If sufficient data is available, a range of expected impacts will be shown below. Click on the hyperlink to be taken to a table displaying the datapoints comprising the range.

TSMO Strategy Selected:
- Freeway Management System : Ramp Metering : Pre-set Timing

Impact Category:
- Travel Time and Speed

Data Source Noted Impacts
- Freeway Management System : Ramp Metering : Pre-set Timing

Provides database and look-up function for the observed impacts of many TSM&O strategies

Typical Range of Expected Impacts
- Expected travel time reductions range between 10% and 45%.
- Expected percent speed improvements between 10% and 55%.
- Expected delay reductions between 15% and 20%.
### FHWA Tool for Operations Benefit/Cost (TOPS-BC)

**Guidance on Appropriate Benefit/Cost Methods**

**Instructions:** Please indicate the needs of your analysis associated with the following criteria then press "GO". A list of appropriate methodologies will be displayed to the right and will change in response to your answers to the input analysis criteria.

#### INPUT CRITERIA

1. What is the geographic scope of the analysis? (Select 1)
   - Do not care
   - Statewide
   - Regional
   - Corridor
   - Isolated Location
   - Other

2. What is the desired accuracy of the analysis results? (Select 1)
   - Do not care
   - High (extremely accurate)
   - Medium
   - Low (order of magnitude)

3. What TSM&O strategy(ies) do you want to analyze?
   - Arterial Management Systems
     - Corridor Traffic Signal Coordination Strategies (Choose multiple)
       - Pre Set Timing
       - Traffic Actuated Timing
       - Centrally Controlled Timing
   - Freeway Management Systems
     - Ramp Metering Strategies (Choose multiple)
       - Pre Set Timing
       - Traffic Actuated Timing
       - Centrally Controlled Timing
   - Transit Management Systems
     - Transit Priority
   - Centrally Controlled Timing

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**Recommended:**

Tools meeting ALL criteria
- TOPS-BC
- BCA.net
- CAL-BC
- EMITS
- FITSEval
- HERS-ST
- IDAS
- MicroBENCOST
- Redbook Wizard
- SCRITS
- SPASM
- STEAM
- Travel Demand Model Methods
- Simulation Methods

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*Guides users to appropriate analysis methodology based on their analysis needs*
Estimates life-cycle costs of many TSM&O strategies – Average Annual Costs and Stream of Costs over time

### FHWA Tool for Operations Benefit/Cost (TOPS-BC)

#### PURPOSE

Estimate Lifecycle Costs of TSM&O Strategies

#### WORK AREA 1 - ESTIMATE AVERAGE ANNUAL COST

**Title: Traveler Information - DMS**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Useful Life</th>
<th>Capital / Replacement Costs (Total)</th>
<th>O&amp;M Costs (Annual)</th>
<th>Annualized Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMC Hardware for Information Dissemination</td>
<td>5</td>
<td>$7,500</td>
<td>$375</td>
<td>$1,875</td>
</tr>
<tr>
<td>TMC Software for Information Dissemination</td>
<td>5</td>
<td>$20,000</td>
<td>$1,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>TMC System Integration</td>
<td>20</td>
<td>$100,000</td>
<td>$5,000</td>
<td>$10,000</td>
</tr>
</tbody>
</table>

**TOTAL Infrastructure Cost** $127,500 $106,875 $116,875

**Incremental Deployment Equipment** (Per Sign Location)

| Communication Line | 25 | $750 | $900 | $930 |
| Variable Message Sign | 25 | $92,500 | $4,400 | $8,100 |
| Variable Message Sign Tower | 25 | $125,000 | $275 | $5,275 |

**TOTAL Incremental Cost** $218,250 $5,575 $14,305

#### INPUT

- Enter Number of Infrastructure Deployments: 1 $116,875
- Enter Number of Incremental Deployments (# of Signs): 2 $28,610
- Enter Year of Deployment: 2012

**Average Annual Cost** $145,485
**TOPS-BC: 4) Benefits Estimation**

**Sketch planning B/C framework provided for many TSM&O strategies. Users may enter data and estimate B/C directly or use as a framework to develop their own customized analysis.**

### FHWA Tool for Operations Benefit/Cost (TOPS-BC)

Estimate Benefits of TSM&O Strategies

**Strategy: Dynamic Message Signs**

| Notes: | For additional information on this analysis method, please see Section X.X.X of the Desk Reference.
For information on alternative methods for performing analysis of this strategy, please see Section X.X.X of the Desk Reference. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Benefits Estimated by this Method:</td>
<td>Travel Time Reliability</td>
</tr>
<tr>
<td>Other Benefits that may be Considered:</td>
<td>Safety, Customer Satisfaction, Agency Efficiency, Emissions, Fuel Use</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact</th>
<th>User Input</th>
<th>Default</th>
<th>Modeled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Number of Vehicles Passing Sign Location(s) (per period)</td>
<td>60,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Vehicle Occupancy</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of Time Sign is Displaying Information</td>
<td>5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Information Being Displayed</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 = Comparative Travel Times
2 = Congestion Warning
3 = Alternative Route Recommendations

| % of Drivers Passing the Sign that Act on the Information | 10% | 10% |  |
| Average Time (Minutes) Saved by Drivers Acting on the Information | 5.5 |  |  |
| Average Time (Minutes) Saved by Drivers Not Acting on the Information | 0 |  |  |

| Average Hours of Vehicle Delay Saved Per Period | 28 |  |  |
| Number of Periods Per Year | 260 |  |  |
| Average Hours of Vehicle Delay Saved per Year | 7,150 |  |  |
| Average Hours of Person Delay Saved per Year | 8,580 |  |  |

$ Value of Person Hour (per hour) $14.00

**Total Average Annual Modeled Travel Time Benefit** $120,120

**User Entered Benefit (Annual $’s)**

**TOTAL AVERAGE ANNUAL BENEFIT** $120,120

Average Annual Equipment Deployment and Replacement Costs $60,000

Average Annual Equipment Operations and Maintenance Costs $25,000

**TOTAL AVERAGE ANNUAL COST** $85,000

**Benefit Cost Ratio (Average Annual Benefits / Average Annual Costs)** 1.41

**Annual Net Benefit (Average Annual Benefits - Average Annual Costs)** $35,120
For More Information

• Please Contact:
  – Jim Hunt – FHWA Office of Operations (jim.hunt@dot.gov)
  – Doug Sallman (dsallman@camsys.com)
  – Jennifer Strasserer (jstrasserer@camsys.com)

• Interim Draft of the Desk Reference Document
  – http://www.camsys.com/kb_pubs_oper.htm

• FHWA Planning for Operations Website
  – http://www.plan4operations.dot.gov