FHWA Operations Benefit/Cost Analysis Desk Reference

Conducting Benefit/Cost Analysis of Strategies Impacting Non-Typical Traffic Conditions

Project Purpose

This brochure provides an overview of analytical methods that may be applied to assess the impacts and benefits of various operations strategies that are targeted at mitigating the negative effects of traffic congestion caused by non-typical conditions such as incidents, high demand (special events), inclement weather, and other causes.

Analyzing operations projects within a conventional benefit/cost analysis framework designed to assess more traditional capacity expansion projects can be challenging since many traditional benefit/cost analyses focus on measurement of project benefits based on "typical" (average demand, good weather, no incident) days.

Many operations strategies, meanwhile, are specifically targeted at non-typical conditions that occur as a result of non-recurring traffic incidents, inclement weather conditions, or periods of high demand. Since a disproportionate amount of the expected benefits of these strategies are incurred during non-typical conditions, the use of conventional analysis methods focused solely on typical recurring conditions will often result in the severe underestimation of potential benefits.

Therefore, a different approach to conducting analysis and benefit/cost estimation for operations strategies is often required to fully assess and capture the expected benefits. In response to the needs of system operators to conduct these specialized analyses, several initiatives have been undertaken in recent years at the national, state, and regional levels to develop enhanced analysis methodologies capable of assessing the benefits of operations strategies specifically targeted at improving travel during non-typical conditions.

Research Into Analyzing the Benefits and Costs of Operational Strategies Impacting Non-Typical Traffic Conditions

The FHWA Office of Operations recently completed the Benefit/Cost Analysis for Operations Planning Desk Reference, in recognition that practitioners were in need of relevant and practical guidance in how to effectively conduct benefit/cost analysis of a wide spectrum of transportation system management and operations strategies. This guidance includes a synopsis of analysis strategies intended to better measure and quantify the benefits of operations strategies impacting non-typical traffic conditions caused by incidents, inclement weather, construction work zones, and special events. Guidance was drawn from many recent and ongoing innovative analysis research projects, including:

- The Integrated Corridor Management (ICM) Analysis, Modeling and Simulation (AMS) Guidebook, developed by the FHWA Office of Operations.
- Guidebook on Analysis of Active Transportation and Demand Management (ATDM) Using Highway Capacity Manual (HCM) Methods, being developed by FHWA Office of Operations.
- Strategic Highway Research Program (SHRP 2) Project L05 – Incorporating Reliability in the Transportation Planning Process.
- SHRP 2 Project L08: Incorporating Reliability in the HCM.

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Methods for Conducting Multi-Scenario Benefit/Cost Analysis Sensitive to Non-Typical Conditions

Benefit/cost analysis is typically used to assess the relative efficiency of an existing or proposed project; therefore, the analysis must include analysis of conditions "without" the project (no-build baseline assessment) and "with" the project. The incremental difference between these two assessments represents the benefits of the project.

Most analysis of non-typical conditions also involves the identification of specific operating conditions that deviate from the typical day, and the development of one or more specific analysis scenarios that represent operating conditions under these unique conditions. This approach is often referred to as multi-scenario analysis.

In adopting a multi-scenario approach within a benefit/cost analysis, the "with" and "without" assessment may need to be performed multiple times under various assumed operating conditions. In conducting this complex analysis it is important to:

- Understand the full range (and distribution) of operating conditions which the analyzed project will be operating under;
- Develop various analysis scenarios that represent alternative operating conditions;
- Assess the likely impact of the project under the different operating scenarios; and
- Annualize the benefit of the project based on the expected distribution (frequency) of operating scenarios.

The first step in the multi-scenario analysis approach is to assess the distribution of operating conditions and the impact these conditions have on traffic performance measures. The assessment of the distribution of operating conditions is ideally conducted using robust archived data sources providing a solid localized accounting of the typical frequency of occurrence of non-typical conditions, including (but not limited to):

- Incident occurrence (and severity);
- Inclement weather; and
- Demand (high or low).

Other factors such as the presence of construction work zones or other factors also may be assessed depending on the study area and proposed project (strategies) being analyzed. The following table represents an average distribution of conditions (and combinations of conditions) developed as part of the FHWA Guidebook on Analysis of Active Transportation and Demand Management Using Highway Capacity Methods. The table compares the frequency of varying levels of demand (presented as percentiles of the demand curve) mapped against varying weather and incident conditions. The second column in the table shows the expected capacity loss related to the specific weather and incident conditions. The entries in the remaining cells are the percent of days over an entire year that the given condition exists for the time period being analyzed. They can be thought of as the probability of a scenario occurring. For example, the value of 6.31 percent in the first row indicates that over the course of a year 6.31 percent of the days have no incidents, good weather, and a demand at the 5th percentile level (low demand).

Once the assessment of the distribution of operating conditions is identified, the analyst will need to identify those non-typical conditions they want to develop as specific scenarios in the multi-scenario approach. Practitioners may opt to focus their efforts on those operating scenarios occurring most frequently or having the most significant negative impact on congestion. Likewise, the analyst will want to map the analysis scenarios to the particular strategies included in the project they want to analyze.

The baseline "without project" scenarios are then developed by altering network capacities, speeds, or other input parameters to represent the change in performance anticipated due to the non-typical conditions being analyzed. Once the identified baseline, "without project" scenarios have been analyzed, the next step is to add in the anticipated impacts from the analysis project and rerun each scenario to generate performance estimates for the "with project" scenarios. The probabilities from the scenario table are then used to weight the results for the "with project" and "without project" cases so that a composite picture of performance emerges. SHRP 2 Project L08 is building a more complex version of the basic model for inclusion in *Highway Capacity Manual* analyses.

A decision support tool, named the Tool for Operations Benefit/Cost (TOPS-BC), was developed in parallel with Benefit/Cost Analysis for Operations Planning Desk Reference. The TOPS-BC tool has a data repository of the observed impacts of a number of different operations strategies and the look-up function imbedded in the spreadsheet tool allows the research of potential impact ranges associated with various strategies and impacts.

The TOPS-BC tool also may be used to assess the benefits associated with strategies on the various operating conditions. The spreadsheet format of the tool makes it easy to adjust input capacities and speeds to represent the various baseline conditions, and provides quick analysis allowing multiple scenarios to be run in little time.

The incremental change between the "with project" and "without project" analyses represents the benefit of the project during the conditions being analyzed.

The final step in the multi-scenario benefit/cost analysis approach is to monetize and annualize the assessed change in performance. The approach used to annualize the benefits under multi-scenario analysis involves estimating the incremental benefit associated with each of the identified operating condition scenarios, and then multiplying that benefit with a factor representing expected frequency of occurrence.

Capacity Scenarios	Capacity Reduction	Demand Scenarios Distribution					Row Total
		5th Percentile	20th Percentile	50th Percentile	80th Percentile	95th Percentile	
No Incidents, Good Weather	0%	6.31%	15.76%	18.92%	15.76%	6.31%	63.05%
Single Lane Closure, Good Weather	35%	0.13%	0.32%	0.39%	0.32%	0.13%	1.29%
Dual+Lane Closure, Good Weather	60%	0.17%	0.42%	0.51%	0.42%	0.17%	1.69%
No Incidents, Bad Weather	4.9%	3.24%	8.11%	9.73%	8.11%	3.24%	32.44%
Single Lane Cruise, Bad Weather	38.2%	0.07%	0.17%	0.20%	0.17%	0.07%	0.66%
Dual+Lane Closure, Bad Weather	62%	0.09%	0.22%	0.26%	0.22%	0.09%	0.87%
Column Totals		10.00%	25.00%	30.00%	25.00%	10.00%	100.00%

In a simplified example, an incident management system could be analyzed by estimating the incremental benefits the project would have on two different scenarios – a minor incident and a major incident. The incident management system would not be expected to have any impact on days without incidents. The analysis of the two scenarios reveals that the project has an average benefit of $20,000 on days with minor incidents and $80,000 on days with major incidents. Likewise, the analysis of the distribution of operating conditions reveals that minor incidents typically occur during 20 percent (73 days) of the year and major incidents occur during 5 percent (~18 days) of the year. To annualize the total benefit of the project, the estimated benefit for each scenario would be multiplied with the expected number of days that operating condition would be expected to occur, or:

(73 minor incident days * $20,000) + (18 major incident days * $80,000) = $2.9M TOTAL BENEFIT

The resulting benefit/cost analysis using a multi-scenario approach often provides a more thorough accounting of the potential benefits of many operations strategies over a more realistic representation of the environment and conditions in which they are anticipated to operate.

Project Contacts

If you have any questions regarding the Benefit/Cost Analysis for Operations Planning Desk Reference http://www.ops.fhwa.dot.gov/publications/fhwahop12028/index.htm or the supporting Tool for Operations Benefit/Cost (TOPS-BC), please contact one of the individuals below:

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