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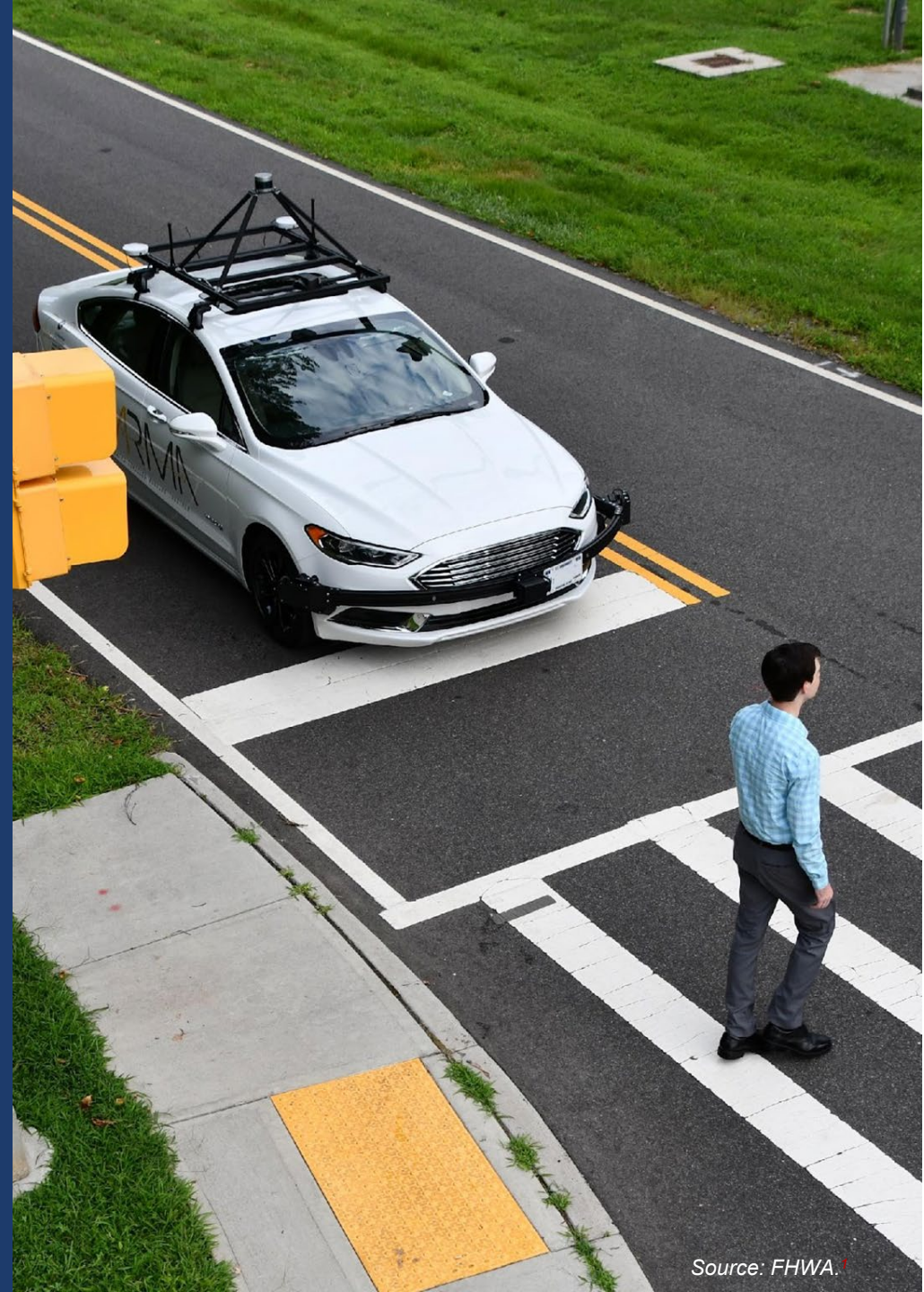
Turner-Fairbank
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Traffic Incident Management Benefit- Cost (TIM-BC) Tool

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December 14, 2021



Source: FHWA.

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Agenda

- ▶ Overview.
 - ▷ Project objective, approach, and status.
 - ▷ TIM-BC tool overview.
- ▶ TIM-BC tool demonstration.
- ▶ Benefit and cost estimation methodologies.
- ▶ Improvements and next steps.



All images source: FHWA.

Overview



Project Overview

- ▶ Goal:
 - ▷ Improve the TIM-BC tool developed through the FHWA's Office of Research, Development, and Technology (RDT), Office of Operations.¹
 - ▷ Make the tool more useful to TIM and other relevant communities.
- ▶ Objectives:
 - ▷ Raise awareness of the tool in relevant communities.
 - ▷ Identify and prioritize potential improvements to the tool.
 - ▷ Facilitate constant engagement between user, researcher, and developer communities.



Project Overview

- ▶ Approaches:
 - ▷ Engage stakeholders through webinars, interviews, and workshops.
 - ▷ Make the tool open source.
 - ▷ Develop complete and clear documentation for end users, researchers, and software developers.

- ▶ Status:
 - ▷ Publish source code—completed.
 - ▷ Publish confluence space—completed.
 - ▷ Conduct interviews and workshop discussions on improvements—planning.

TIM-BC Tool Overview



Tool capabilities:

- ▶ Benefit and cost estimation for a range of TIM strategies.
- ▶ Evaluation of monetary value of TIM programs.
- ▶ Estimation of benefits in terms of:
 - Travel delay.
 - Fuel consumption.
 - Emissions.
 - Secondary incidents.

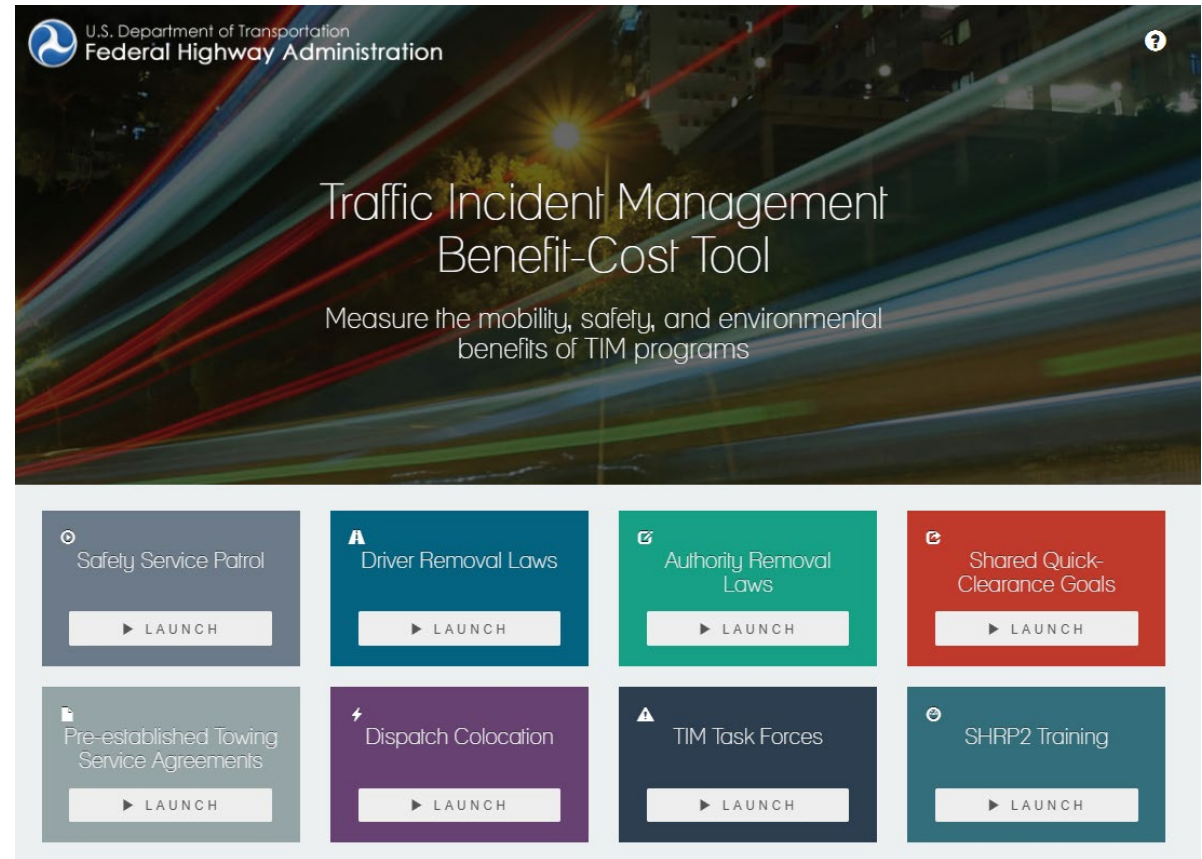
Source: FHWA¹.

TIM-BC Tool Overview



Features include:

- ▶ Tool is simple to use.
- ▶ Data requirements are less intense than those of previous generations of tools.
- ▶ Estimation methodologies are standardized and universal.



Source: FHWA¹.

TIM-BC Tool Overview



- ▶ Intended Usage:
 - ▶ Assess proposed expansion of existing TIM programs.
 - ▶ Assess the value of creating a new TIM program.
 - ▶ Compare alternatives.

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Traffic Incident Management Benefit-Cost Tool

Measure the mobility, safety, and environmental benefits of TIM programs

- Safety Service Patrol
- Driver Removal Laws
- Authority Removal Laws
- Shared Quick-Clearance Goals
- Pre-established Towing Service Agreements
- Dispatch Colocation
- TIM Task Forces
- SHRP2 Training

Source: FHWA¹.



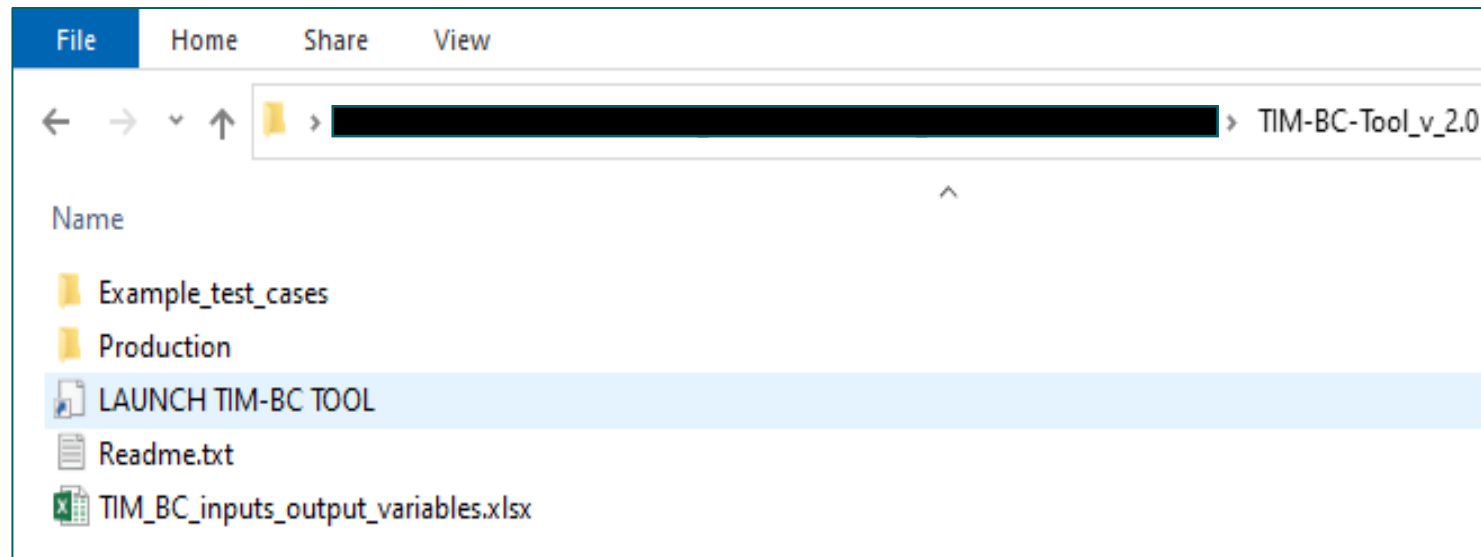
All images source: FHWA.

TIM-BC Tool Demonstration

Install and Launch the Tool



- ▶ Download the tool from <https://www.fhwa.dot.gov/software/research/operations/timbc/>.¹
- ▶ Unzip the downloaded file “TIM-BC-Tool_v_2.zip.”
- ▶ Double click the shortcut “LAUNCH TIM-BC TOOL” under the unzipped root folder “TIM-BC-Tool_v_2.0.”



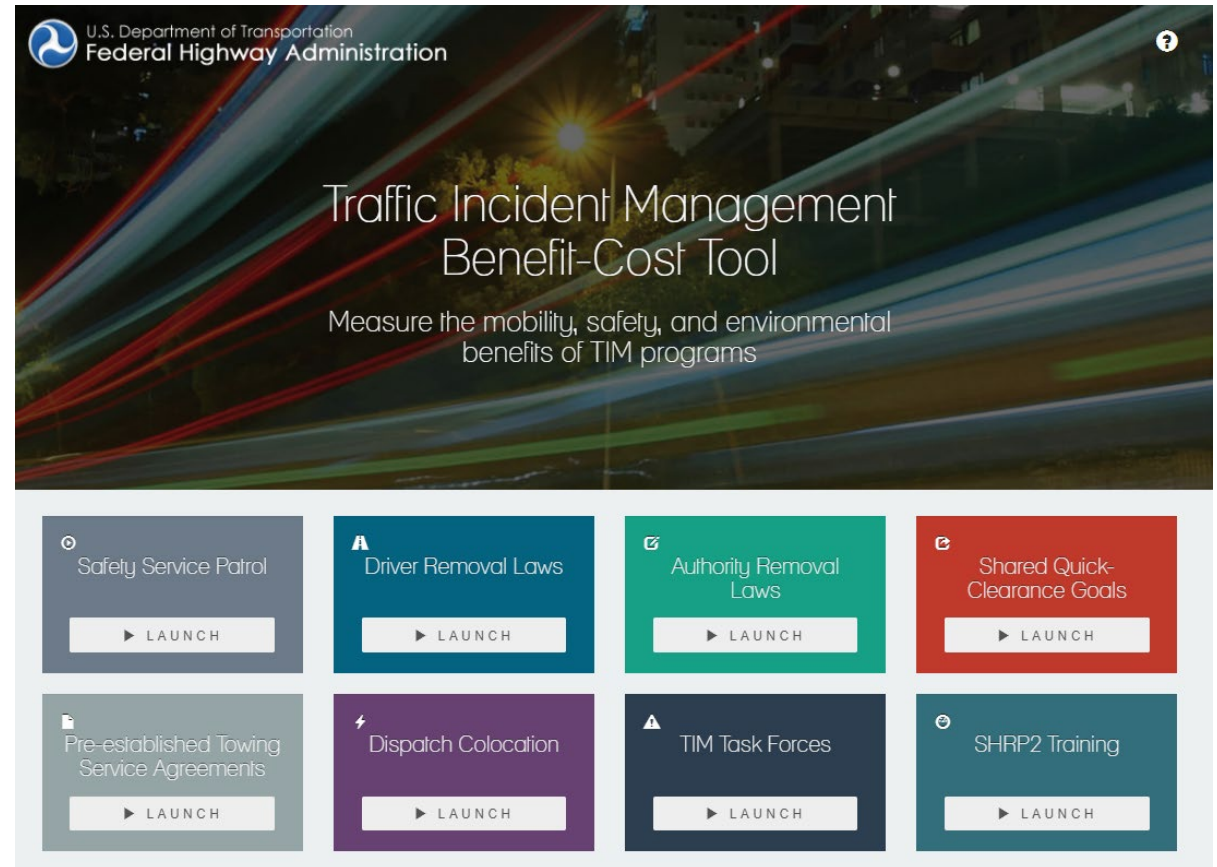
Source: FHWA.

Home Screen of the TIM-BC Tool



Select a module:

- ▶ Safety Service Patrol (SSP).
- ▶ Driver Removal Laws.
- ▶ Authority Removal Laws.
- ▶ Shared Quick-Clearance Goals.
- ▶ Preestablished Towing Service Agreements.
- ▶ Dispatch Colocation.
- ▶ TIM Task Forces.
- ▶ Strategic Highway Research Program 2 Training.



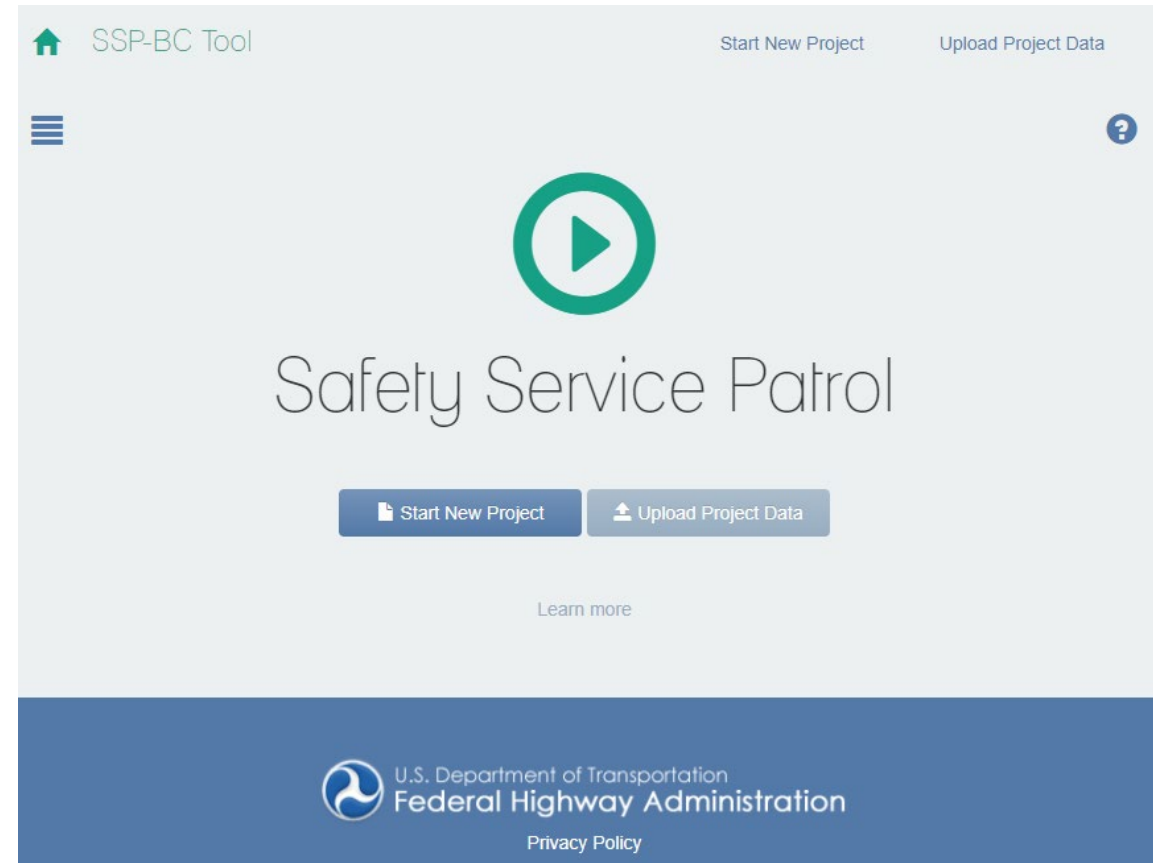
Source: FHWA¹.

Example BC Estimation: Safety Service Patrol



Home screen for Safety Service Patrol (SSP) BC Module:

- ▶ Select Start New Project button for a new SSP BC estimation project.
- ▶ Select Upload Project Data to load data.



Source: FHWA¹.

SSP BC Estimation Example



- ▶ Enter project name.
- ▶ Input project details.
 - ▷ State.
 - ▷ Number of Segments (highway segments in TIM program).
 - ▷ Study period duration in months.
 - ▷ Annual Total Program Cost.

SSP-BC Tool

Save Project Data Start New Project Upload Project Data

SSP example BC estimat ✕

Edit Project Details ▶

Upload Project Data

SSP-BC Tool

Save Project Data Start New Project Upload Project Data

SSP example BC estimation project

State: ⓘ
Alabama

Number of Segments: ⓘ
1

Study period duration in months: ⓘ
12

Annual Total Program Cost: ⓘ
0

Calculate

Project Name Segment Input

Source: FHWA¹.

SSP BC Estimation Example



- ▶ Input segment information:
 - ▶ Roadway Geometry.
 - ▶ DRL (TIM) Program Information.
 - ▶ Incident Information.
 - ▶ Traffic (and weather) Information.
- ▶ Calculate BC ratio by inputting data into all four blocks to meet minimum requirements (indicated by the block header turning green).

DRL example BC estimation project

Segment: Segment 1

Enter Segment Name

Select Region

Roadway Geometry

SEGMENT LENGTH IN MILES: 0

NUMBER OF RAMPS: 0

NUMBER OF TRAFFIC LANES BY DIRECTION: 2

GENERAL TERRAIN: Flat

HORIZONTAL CURVATURE: Straight

DRL Program Information

OPERATION TIME:

AM Peak

PM Peak

Weekday Off Peak

Weekend

PROJECT SAVINGS:

PROPORTION: 50

COMPLIANCE RATE (BEFORE): 0

COMPLIANCE RATE (AFTER): 50

AVERAGE SHORTENED INCIDENT DURATION: 5

Traffic Information

POSTED MAINLANE SPEED LIMIT (MPH): 0

Time	Traffic Volume (VEH/H/Lane)	Truck Percentage (0-25)
AM PEAK	0	0

Weather Information (ensure selections add up to 100%)

WEATHER: Select Type

PERCENTAGE (0-100): 0

Incident Information

AM Peak

Incident Blockage Severity	Average Incident Duration (Minutes)	Number of Incidents
Shoulder Blockage	0	0
One Lane Blockage	0	0

PERCENTAGE OF ESTIMATED SECONDARY INCIDENTS (enter as 0-100): 0

Buttons: Calculate Ratio, Reset Information

Source: FHWA¹.

SSP BC Estimation Example



- ▶ Project output:
 - ▶ Summarizes the calculated benefit elements and BC ratio of the SSP program.
 - ▶ Includes the following benefits:
 - DELAY SAVINGS (HOURS).
 - FUEL (GALLONS) savings.
 - SECONDARY ACCIDENTS (for prevention).
 - Emission reductions (metric tons), including HYDROCARBONS, CARBON MONOXIDE, and others.
 - ▶ Exports PDF reports with the results.

SSP-BC Tool

Save Project Data Start New Project Upload Project Data

test06

Segments:

Select All Select None

testSegment01

PRODUCE REPORT

Savings

Study period duration: 6 months

DELAY SAVINGS (HOURS):	53669.76	<input checked="" type="checkbox"/>
FUEL (GALLONS):	-36.96	<input checked="" type="checkbox"/>
SECONDARY ACCIDENTS:	5.09	<input checked="" type="checkbox"/>
HYDROCARBON (HC, MT):	0	
CARBON MONOXIDE (CO, MT):	-0.02	
NITROGEN OXIDE (NOx, MT):	0	
CARBON DIOXIDE (CO2, MT):	-0.37	
SULFUR OXIDE (SOx, Grams):	-0.01	

BENEFIT-COST RATIO OF CHOSEN FACTORS:

18.43

Source: FHWA¹.



TIM-BC Tool V2.0

Demo.



All images source: FHWA.

Benefit and Cost Estimation Methodologies

Benefit Estimation



DRL Test Project

Segment: Segment 1

Enter Segment Name

Richmond, VA

Roadway Geometry

SEGMENT LENGTH IN MILES: 5

NUMBER OF RAMPs: 0

NUMBER OF TRAFFIC LANES BY DIRECTION: 4

GENERAL TERRAIN: Flat

HORIZONTAL CURVATURE: Straight

DRL Program Information

OPERATION TIME:

AM Peak

PM Peak

Weekday Off Peak

Weekend

PROJECT SAVINGS:

PROPORTION: 50

COMPLIANCE RATE (BEFORE): 0

Benefit: applicable incidents

COMPLIANCE RATE (AFTER): 50

AVERAGE SHORTENED INCIDENT DURATION: 0

Benefit: incident duration reduction

Incident Information

AM Peak

Incident Blockage Severity	Average Incident Duration (Minutes)	Number of Incidents
Shoulder Blockage	0	0
One Lane Blockage	0	0
Two Lane Blockage	0	0
Three Lane Blockage	0	0

Incident information

PERCENTAGE OF ESTIMATED SECONDARY INCIDENTS (0-100): 0

Benefit: secondary incidents

Traffic Information

Source: FHWA¹.



Benefit Estimation

- ▶ User input: Estimated reduction of incident duration (average or by lane blockage).
- ▶ User input: Estimated percentage of incidents (by lane blockage).
Select the TIM program of interest.
- ▶ User input: Estimated number of secondary incidents.
- ▶ Tool output based on user input: Overall estimated benefits in terms of travel delay, fuel consumption, emissions, and secondary incidents for the TIM program of interest.



Benefit Estimation

Travel delay and fuel consumption estimation:

- ▶ Data analysis results based on hundreds of thousands of microscopic traffic simulation runs.
- ▶ Traffic simulation model calibrated using Maryland freeway data.
- ▶ Combinations of all experimental characteristics calculated using:
 - ▷ Incident: lanes and lane-blockage scenarios.
 - ▷ Traffic: free-flow speed, composition, and volume variables.
 - ▷ Geometry (roadway curvature and terrain) and weather conditions captured through adjusted free-flow speed.



Benefit Estimation

Emission estimation:

Based on fuel consumption estimation and data from the U.S. Environmental Protection Agency (EPA).

Benefit Estimation



Estimates travel delay (hours):

- ▶ Regresses empirical equations from simulated data.
- ▶ Calculates total delay as a function of incident duration, lane blockage, adjusted free-flow speed, volume, percentage of trucks, and roadway gradient.

$$\text{Log}(TDc) = -1.59 - 0.013 (\text{NoOfLaneIndex1}) + 0.55 (\text{Duration}) - 0.04 (\text{DurationP2}) + 0.01 (\text{FFS}) + 0.02 (\text{Comp}) + 11.73 (\text{Volume}) - 5.04 (\text{VolumeP2}) + 0.71 (\text{VolumeP3}) + 0.15 (\text{Gradient})$$

$$\text{Log}(TDt) = -4.30 - 0.01 (\text{NoOfLaneIndex1}) + 0.34 (\text{Duration}) + 0.01 (\text{FFS}) + 0.94 (\text{SqrComp}) + 6.84 (\text{Volume}) - 3.00 (\text{VolumeP2}) + 0.47 (\text{VolumeP3}) + 0.49 (\text{Gradient}) - 0.03 (\text{GRadienP2})$$

TDc =	Total travel delay of cars (hours)
TDt =	Total travel delay of trucks (hours)
LogTDc =	Ln(TDc)
LnTDt =	Ln(TDt)
NofLaneIndex1 =	(Number of open lanes / Number of lanes in each direction)*100
Duration =	Incident duration (hours)
DurationP2 =	Incident duration ² (hour ²)
FFS =	Free-flow speed (km/h)
Comp(*10k) =	Traffic composition – percentage of trucks
SqrComp =	Percentage of trucks power 0.5
Volume =	Traffic volume (vplph, 1,000)
VolumeP2:	Traffic volume power 2 (vplph ² , 1,000 ²)
VolumeP3	Traffic volume power 3 (vplph ³ , 1,000 ³)
Gradient	Roadway gradient
GradientP2:	Roadway gradient power 2 (percent ²)

Benefit Estimation



Estimates fuel consumption benefit (gallons):

- ▶ Hybrid statistical-simulation approach used.
- ▶ Lookup table produced from simulation in terms of incident duration, lane blockage, adjusted free-flow speed, and volume (with zero trucks on flat road).
- ▶ Regression component added with respect to percentage of trucks and roadway gradient.

Fuel consumption of an incident for the scenario with nonzero percentage of trucks and gradient is: fuel consumption computed for remodeled incident based on the vehicle record output file from microscopic simulation + $e^{0.001(\text{percentage of truck}) - 0.015(\text{gradient}) + 0.001(\text{gradient}^2)}$.



Benefit Estimation

Estimates emissions (metric tons):

- ▶ Estimated fuel consumption multiplied by emission factor, fuel economy (when applicable), and fuel properties (when applicable).
- ▶ Emission factor and fuel economy data obtained from EPA.



Benefit Estimation

Converting benefits to monetary equivalents:

Relevant Data	Related Benefits	Data Source
Average gasoline prices	Fuel consumption	U.S. Energy Information Administration
Average labor costs	Travel delay	U.S. Department of Labor
Commercial vehicle costs per hour	Travel delay; fuel consumption	American Transportation Research Institute
Secondary incident cost	Secondary incidents	National Highway Traffic Safety Administration

Source: FHWA



Cost Estimation

- ▶ Detailed inputs and calculation for SSP.

SSP-BC Tool

Save Project Data Start New Project Upload Project Data

SSP example BC estimation project

State: Alabama

Number of Segments: 1

Study period duration in months: 12

Annual Total Program Cost: 0

Calculate

Project Name Segment Input

Source: FHWA¹.

Calculate Program Cost

Annual Total: \$ 0

Annual Fixed Cost: 0

Patrol Vehicle Type	Number of Vehicles	Driver's Hourly Rate (\$/hr)	Working Hours per Day	Working Days per Month	Fuel (gal/month)	Provided Gas (\$/month)	Vehicle Maintenance (\$/month)	Other (\$/month)	Monthly Total
Vehicle Type	0	0	0	0	0	0	0	0	\$ 0

Submit Add Row

Source: FHWA¹

- ▶ Lump-sum user inputs for other TIM strategies.



All images source: FHWA.

Improving the TIM-BC Tool

Next Steps



Recap: Project Overview

- ▶ **Goals:**
 - ▷ Improve the TIM-BC tool developed through the FHWA's Office of RDT, Office of Operations.¹
 - ▷ Make the tool more useful to TIM and other relevant communities.
- ▶ **Approaches:**
 - ▷ Engage stakeholders through webinars, interviews, and workshops.
 - ▷ Make the tool open source.
 - ▷ Develop complete and clear documentation for end users, researchers, and software developers.

Your Feedback Is Needed



- ▶ Download and use/test the tool.
- ▶ Learn more about the tool:
 - ▷ TIM-BC confluence page: resources for end users, researchers, and developers.
 - ▷ TIM-BC tool source code.
- ▶ Look for an email in January: stakeholder feedback questionnaire.
- ▶ Attend a workshop planned for February:
 - ▷ Topic: potential improvements to the TIM-BC tool.
 - ▷ Target audience:
 - TIM program managers, transportation engineers, and policy makers, who are the end users.
 - Researchers and developers, who are involved in aspects including BC analysis methodologies, data sources, software architecture, and interfaces.

Questions?



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