Data-Driven Safety Analysis in the Project Development Process

Agenda

- Safety Data Overview
- What is Data-Driven Safety Analysis?
- DDSA in Project Development
  - Planning
  - Alternatives Analysis
  - Design
  - Construction, Operations, and Maintenance
- Implementation Advancement
Agenda

- Safety Data Overview
- What is Data-Driven Safety Analysis?
- DDSA in Project Development
  - Planning
  - Alternatives Analysis
  - Design
  - Construction, Operations, and Maintenance
- Assistance Available

23 CRF 924
Highway Safety Improvement Program

Federal program to significantly reduce the occurrence of and potential for fatalities and serious injuries on all public roads
Implemented through State-administered processes

1. Process for collecting and maintaining safety data
2. Process for advancing safety data
3. Process for updating the SHSP
4. Process for analyzing safety data
5. Process for conducting engineering studies
6. Process for establishing priorities for implementing highway safety improvement program projects
Types of Safety Data

- Crash Data
- Roadway Data
- Traffic Data

Federal Guidelines for Safety Data Elements

Model Minimum Uniform Crash Criteria (MMUCC), 5th ed. 2017
- Federal guideline for States’ collection of motor vehicle crash data
- 115 elements (crash)

Model Inventory of Roadway Elements (MIRE), 2nd ed. 2018
- Federal guideline for States’ collection of traffic and roadway data on all public roads
- 205 elements (roadway and traffic)
Safety Data Elements

**Crashes**
• Crash location
• First harmful event
• Contributing circumstances – roadway environment

**Roadway**
• Functional class
• Driveway count
• Shoulder type

**Traffic**
• AADT
• 85th percentile speed
• Hourly traffic volumes

Safety Data is Big Data

6.4 million crashes occurred in 2017 nationally
• 736 million possible data elements recorded into State crash databases each year

4.12 million miles of roadway in the United States
• For roadway segments, States potentially collect 109 elements
• For intersections, States potentially collect 57 elements

→By 2026, Congress has mandated States to complete collection of MIRE fundamental data elements (37) on all public roads.

https://safety.fhwa.dot.gov/fde/
Innovation Overview

Interesting Times

- Shrinking budgets
- Growing lists of needs
- Increasing fatalities
- Establishing Safety (and other) performance measures

➢ We need to know how a roadway will perform in terms of safety
What is DDSA?

• The application of the latest evidence-based tools and approaches to safety analysis
• Provides reliable estimates of an existing or proposed roadway’s expected safety performance
• Helps agencies quantify the safety impacts of transportation decisions, similar to the way agencies quantify:
  - traffic growth
  - environmental impacts
  - traffic operations
  - pavement life
  - construction costs

The EDC Data-Driven Safety Analysis Initiative...

Goal: Integrate safety performance into ALL transportation investment decisions
The AASHTO Highway Safety Manual has resulted in the development of:

- Spreadsheets
- Software Products
- Guidance Documents
- Crash Modification Factors Clearinghouse

Where can DDSA be applied in the Project Development Process?
Applying DDSA in Project Development Process

DDSA in Planning

Source: FHWA
Safety in the Planning Process

Agency’s Goal: a performance-based transportation planning process to identify programmatic, policy, and project priorities to address current and future needs

DDSA in the Planning Process

DDSA tools can be applied to help identify which roadways aren’t performing as they should, determine the scope and need of potential projects, and prioritize them.

DDSA in the Planning Process

• **System Level Planning**
  • Network Screening

• **Project Level Planning**
  • Establishing Project Scope
  • Project Prioritization

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Example: Virginia DOT – Safety Performance in Project Prioritization

**Project Weighting Factors**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Congestion Mitigation</th>
<th>Economic Development</th>
<th>Accessibility</th>
<th>Safety</th>
<th>Environmental Quality</th>
<th>Land Use</th>
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<td>15%</td>
<td>30%</td>
<td>10%</td>
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</tr>
</tbody>
</table>

Credit: Virginia DOT
Example: Virginia DOT - Planning-Level CMFs for each project type

e.g. converting 2-lane road to 4-lane divided:

1. Countermeasures and CMF values combined to develop 1 CMF for each project type
   - e.g. CMF = 0.80 (20% crash reduction)

2. CMF applied to previous crash history
   - e.g. 2 F+SI Crashes avoided per year

3. This value is used for the safety portion of the project score

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NC and KY – Safety Benefit Factors

Kentucky: Strategic Highway Investment Formula for Tomorrow (SHIFT)

- Safety performance (25%)
- Congestion Red. (20%)
- Economic growth (20%)
- Existing assets (15%)
- Benefit/Cost (20%)

North Carolina: Strategic Transportation Investments (STI)

- Congestion (30%)
- Benefit-Cost (25%)
- Freight (25%)
- Safety performance (10%)
- Economic Comp. (10%)
DDSA tools can predict the number and severity of crashes for each project alternative, allowing safety performance to be considered along with other project criteria.
When might a more-robust safety analysis in the environmental phase be appropriate?

- When Safety is included in the Purpose and Need
- Projects that claim a safety benefit
- Projects where there could be a substantial difference in safety for the alternatives being considered
- Projects with existing safety issues
Example: OH DOT – DDSA Process Diagrams

Example: TN DOT – Communicating Alternatives

TN Corridor Project
Example: TN DOT – Communicating Alternatives
TN Corridor Project

Conflict Point Analysis

Conflict point diagrams give a graphical sense of the relative crash risk between alternatives. Conflict points were plotted for the entirety of each concept. These diagrams show a significant reduction in potential crash sites due to some design choices, such as adding a median to restrict left turns or converting intersections to roundabouts. These changes result in fewer conflict points, which correlates with improved safety. The combination of graphics and tabulations reinforces the comparison.

Projected Future Crashes

The Highway Safety Manual (HSM) includes techniques to directly quantify projected crashes. FHWA’s Interactive Highway Safety Design Model uses HSM methodology to incorporate specific design elements and projected volume growth. The resulting projected future crashes for each alternative were aggregated corridor-wide. HSM predicted that adding a median would significantly reduce future crashes between intersections, in contrast to a crash increase without access management. Similarly, implementing roundabout control was predicted to reduce future crashes at intersections by 29% from the no-build condition.

This analysis technique illustrates the benefits of access management between intersections and of roundabout control at intersections.
Example: TN DOT – Communicating Alternatives
TN Corridor Project

Travel Time

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Existing Conditions (2016 volumes)</th>
<th>Average Corridor Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>4min 20sec 19.9 mph</td>
<td>19 sec 110 sec 200 seconds</td>
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</tr>
<tr>
<td>5min 40sec 14.9 mph</td>
<td>No-Build Condition (2041 volumes)</td>
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<tr>
<td>5min 30sec 15.4 mph</td>
<td>Four-Lane Concept (median divided)</td>
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<tr>
<td>4min 50sec 17.5 mph</td>
<td>Five-Lane Concept (unrestricted)</td>
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<td>4min 35sec 18.2 mph</td>
<td>Roundabout Corridor Concept</td>
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<tr>
<td></td>
<td>5 min 155 sec 375 sec 510 seconds</td>
<td></td>
</tr>
</tbody>
</table>

Presenting analysis results and conclusions in a way that’s understandable...
DDSA in Design

Source: FHWA

DDSA in the Design Process

DDSA can be used to determine *optimal* design criteria, considering both safety and cost.

- DDSA helps justify flexibility in design
  - design exceptions
  - performance-based practical design
Performance-based Practical Design

An approach to decision-making that encourages engineered solutions rather than reliance on maximum values or limits found in design specifications.

Characteristics
- grounded in performance management
- exercises engineering judgment to address purpose and need
- uses appropriate performance-analysis tools
- considers both short- and long-term project and system goals

Example: MN DOT – PBPD
US Hwy 10 Access Study

Source: Bolton & Menk
Credit: Anoka County and Minnesota DOT

Operation Benefit-vs-Project Cost

Do Nothing
Immediate Priorities
Short Term Priorities
Mid Term Priorities
Opportunity Driven

Previous Freeway Vision

Cost ($M)

Source: Bolton & Menk
Credit: Anoka County and Minnesota DOT
Example: MN DOT – Communicating PBPD
US Hwy 10 Access Study

Safety Benefit-vs-Project Cost

Immediate Priorities
- 6 Projects
- $30M

Short Term Priorities
- 4 Projects
- $10M - $30M

Mid Term Priorities
- 7-9 Projects
- $30M - $60M

Opportunity Driven
- 7-9 Projects
- $10M - $40M

Previous Freeway Vision

Percent of Freeway Safety Benefit

Cost ($M)

Do Nothing

$0

$50

$100

$150

$200

$250

$300

Source: Bolton & Menk
Credit: Anoka County and Minnesota DOT

every day counts

Construction, Operations, and Maintenance

Source: FHWA
DDSA in Construction, Operations, and Maintenance

- Interstate Access Requests
- Intersection Control Evaluation (ICE)
- Traffic Impact Studies
- Transportation Systems Management and Operations (TSMO)
- Performance Management

Traffic Impact Analyses

- Proposed Development
  - Identify the Study Area
  - Develop the Site Plan
  - Develop Ingress/Express Conceptual Plan
  - On-Site/Off-Site Land Use Development

- Existing Conditions
  - Document Physical Characteristics
  - Collect Traffic Volumes and Non-motorized Data
  - Identify and Obtain Safety Data
  - Evaluate Pedestrians and Bicycle Accommodations
  - Summarize Data and Identify Safety Issues
  - Perform Capacity/Queueing Analysis for Existing Conditions

- Projected Growth
  - Background Traffic Forecasting
  - On-Site and Off-Site Development Traffic Forecasting
  - Build and No-Build Conditions Total Traffic

- Traffic Analysis
  - Develop Preliminary Alternatives
  - Evaluate Site Access
  - Perform Capacity/Queueing Analysis
  - Traffic Control/Geometric Consideration
  - Perform Safety Analysis of Each Preliminary Alternative
  - Compare Alternatives and Make Recommendations

(Black: typical traffic impact assessment step
Bold: opportunity to integrate safety)
Analyzing Operations and Safety

How has implementing a TSMO strategy (or combination of strategies) impacted safety performance? (evaluation)

- Or how will it impact safety performance? (prediction)

3 general sets of approaches considered

- Analysis of crash data
- Alternative (i.e., surrogate) measures of safety
- Simulating crash occurrence and severity
### Synthesis of Safety Performance Information

- **Managed Lanes**
  - HOV/HOT Lanes
  - Truck Lanes and Truck Restrictions
  - Bus Lanes
- **Part-Time Shoulder Use**
- **Reversible Lanes**
- **Dynamic Lane Use Control**
- **Dynamic Junction Control**
- **Ramp Metering**
- **Variable Speed Limits**
- **Traffic Signal Coordination**

- **Adaptive Signal Control Technology**
- **Transit Signal Priority**
- **Truck Signal Priority**
- **Queue Jump Lanes**
- **Safety Warning Applications**
  - Intersection Warning
  - Curve Warning
  - Queue Warning
  - Animal Warning
- **Work Zone Management**
- **Traffic Incident Clearance**

### Integrating Safety Performance

[YouTube Video](https://www.youtube.com/watch?v=6h7E8i6rey8&t=9s)
EDC-4 Goals

• Increase the number of States that have applied DDSA on one or more projects (demonstration level).
• Increase the number of States that have integrated DDSA in their project development process (assessment or institutionalized levels).
• Increase the number of States with crash, roadway, and traffic volume data collected and integrated on all public roads.
• Identify and increase the number of local agencies with local road safety plans.
• Increase the number of projects and percent of HSIP funding applied to local roads.
DDSA State Results

- Under EDC, 24 States began applying DDSA in the project development process
- 48 States + Federal Lands have now used DDSA on one or more projects
- Under EDC-4, 19 States advanced implementation stages
- 20 States received significant technical assistance
  - 10 states that established or updated policies and procedures
  - 4 Developed DDSA Implementation Plans

For more information...

- Fact Sheets and Case Studies
- Infographics
- Videos
- Webinars
- Informational Guides
- Training Workshops
- Technical Assistance

“A game changer in traffic safety”

Questions?

Betsey Tramonte
FHWA – Louisiana Division
225.757.7613
betsey.tramonte@dot.gov

Jerry Roche, P.E.
FHWA – Office of Safety
515.233.7323
jerry.roche@dot.gov

*FHWA cites specific tools as examples of ways to implement safety analysis approaches, not as an endorsement of these tools over others.