Reliability of Safety Management Methods
Systemic Safety Programs

Presented by
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Outline

 Project Background
 Describe Problem
 Research Methods
 Interpreting Results
 Implications for Practice
Manage

Managers that understand the costs and benefits of alternative business practices can effectively and efficiently manage the agency’s safety program. This section offers information about data-driven decision-making and planning including the costs and benefits of state-of-the-art analysis methods and the data management and governance structures required to support alternative methods. These tools can help managers in developing policies and practices, setting budgets, allocating resources, making safety investments, identifying training needs, and managing a safety program.

FHWA Roadway Safety Data and Analysis Toolbox

https://safety.fhwa.dot.gov/rsdp/
Reliability of Safety Management Methods

Series of Guides

- Network Screening
- Network Screening Measures
- Diagnosis
- Countermeasure Selection
- Safety Effectiveness Evaluation
- Systemic Safety Programs

https://safety.fhwa.dot.gov/rsdp/
Systemic Safety Programs Guide

- Define “crash-based” and “systemic” projects
- Characterize state-of-the-practice
- Demonstrate value of systemic approach
- Guidance for allocating funds
Crash-Based and Systemic Projects
Start with the Basics

- Crashes occur with frequency and severity
- Caused by driver, vehicle, roadway, or other
- Engineering-related improvements:
  - Fix geometric or traffic deficiencies
  - Reduce negative impacts of other factors
- Spectrum of project types
Crash-Based Projects

- Sites have unique crash experience
- **Address sites with high PSI**
- One project per site
- **Diagnose every location**
- Unique countermeasures
- Higher effectiveness
- Lower efficiency

- Example: Roundabout
Systemic Projects

- Many sites have similar experience
- System-level diagnosis
- **Target specific concern**
- Many sites per project
- Predetermined countermeasures
- Lower effectiveness
- Higher efficiency

- Example: Flashing Yellows
Difference is in the Diagnosis

Crash-Based (Hotspot)
- Select and treat sites based on site-specific safety concerns

Systemic
- Select and treat sites based on network-wide safety concerns

Both methods can have:
- High or low cost treatments
- Basic to advanced methods
- High or low treatment effectiveness
How to Compare Effectiveness?

- Many interpretations of systemic in practice
- No information about systemic approach
- Difficult to identify systemic projects
- Minimal data about pretreatment frequency
- Wide range of potential costs
- Wide range of CMFs
How to Compare Effectiveness?

Crash-Based (Hotspot)
- Select and treat sites based on site-specific safety concerns
- Higher unit cost
- Higher effectiveness

Systemic
- Select and treat sites based on network-wide safety concerns
- Lower unit cost
- Lower effectiveness

Typical Implementations....

Crash-Based
- Higher unit cost
- Higher effectiveness

Systemic
- Lower unit cost
- Lower effectiveness
Value of Systemic Projects
General Method

- Select crash-based and systemic countermeasures
- Analyze countermeasure data
- Consider hypothetical implementations
- Compare effectiveness
Characterize Typical Projects

- Select treatments for study
- Collect implemented project data
  - 2014 HSIP reports
  - FHWA research
  - State databases
- Some simple before-after evaluation data
Crash-Based Countermeasures

- Add left turn lane
- High friction surface
- Reconfigure intersection
- Reduce skew and add LTL
- Road diet w/o resurface
- Road diet with reconstruction
- Roundabout
Systemic Countermeasures

- Cable median barrier
- Rumble strips
- Horizontal curve warning signs
- Ramp curve warning signs
- Various signal improvements
- Various stop improvements
Methodology

- $10,000,000 of each countermeasure
- Average cost per site
- Average CMF
- Average frequency before treatment
## Hypothetical Implementations

<table>
<thead>
<tr>
<th>Economic Measure</th>
<th>Crash-Based</th>
<th>Systemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Cost</td>
<td>$9,901,286</td>
<td>$9,998,000</td>
</tr>
<tr>
<td>Average Benefit</td>
<td>$226,519,265</td>
<td>$700,219,396</td>
</tr>
<tr>
<td>Overall Benefit-Cost Ratio</td>
<td>23.0</td>
<td>70.0</td>
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</tbody>
</table>
Allocating Funding
Typical Network Screening
When to Apply Each Approach

Statewide Distribution of Expected Intersection Crashes

- Opportunity for crash-based projects
- Opportunity for systemic projects
Project Breakeven Equation

\[ ACF = \frac{AVC_C - AVC_S}{CC \times (CMF_S - CMF_C)} \]

ACF = breakeven average crash frequency
AVC = annualized project costs
CC = average crash cost
CMF = crash modification factor
Applying the Breakeven Equation

- Determine sites that warrant higher investment
- Use for average project costs and CMFs
- Use for site-specific alternatives

- When $CMF_C > CMF_S$ and $AVC_C > AVC_S$ (or vice versa), choice is obvious
Comprehensive Safety Programs
When to Use Each Approach?

Opportunity: Treat few sites w/ many crashes per site.

Benefit: Potential for large crash reduction at site level.

Considerations: High cost and high risk associated with fewer high-cost projects.

Opportunity: Treat many sites w/ few crashes per site.

Benefit: Potential for large crash reduction at system level.

Considerations: Small crash reduction at site level, but low cost and low risk.

Crash Reduction (per site)

Project Cost (per site)

Investment Risk
## Example Calculation with Average Data

<table>
<thead>
<tr>
<th>Data</th>
<th>Crash-Based</th>
<th>Systemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average CMF</td>
<td>0.73</td>
<td>0.90</td>
</tr>
<tr>
<td>Average cost per site</td>
<td>$20,000</td>
<td>$750</td>
</tr>
<tr>
<td>Average crash cost</td>
<td>$55,900</td>
<td>$55,900</td>
</tr>
</tbody>
</table>

\[
ACF = \frac{\$20,000 - \$750}{\$55,900 \times (0.90 - 0.73)} = 2.0
\]
Optimization Example

Breakeven Threshold = 2.0 crashes/site/year

Budget: $10M
Average cost: $20,000/site
Opportunity: Treat 500 sites
Average benefit: 27% crash reduction
Overall benefit: Potential for large crash reduction at site level

Budget: $10M
Average cost: $750/site
Opportunity: Treat 13,333 sites
Average benefit: 10% crash reduction
Overall benefit: Potential for large crash reduction at system level
Comprehensive Safety Programs

- Cannot solely address site-specific concerns
- Cannot solely address network-wide concerns
- ~75% of HSIP to crash-based projects
Considerations

Strengths and limitations

Objectives (policy, goals, other)

SHSP and performance targets

Data requirements

Jurisdiction and agency
Considerations (cont’d)

Future research needs

Tracking systemic projects

• Prepare for evaluations
• Specific locations, not corridors
• Site-specific/typical countermeasure data
• Project type
Summary

- “Crash-based” and “Systemic”
- Hypothetical implementations
- Breakeven equation
- Consider objectives
Acknowledgements

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