Evaluation of Work Zone ITS Deployments

Praveen Edara, Carlos Sun, Andrew Robertson
University of Missouri - Columbia

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1. Find you must what WZ ITS research exists
2. Summarize you must the main findings
3. Tell you must how agencies can evaluate future WZ ITS deployment
4. Provide you must case studies from Missouri
5. "Always pass on what you have learned" - Yoda
WZ ITS Evaluation Literature

Edara et al. 2014

WZ ITS Deployments Evaluated
# Past WZ ITS Deployments

<table>
<thead>
<tr>
<th>Work Zone ITS</th>
<th>Study Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay and alternate routes</td>
<td>86.4 % diverted</td>
</tr>
<tr>
<td></td>
<td>5 to 9 % diverted. Travel time savings of ~ 4 minutes</td>
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<tr>
<td></td>
<td>Up to 28 % diverted</td>
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<tr>
<td></td>
<td>4% diverted</td>
</tr>
<tr>
<td>Alternate routes</td>
<td>8 to 10 % diverted</td>
</tr>
<tr>
<td>Delay and Travel time information</td>
<td>5 to 10 % diverted</td>
</tr>
<tr>
<td>Queue information</td>
<td>Diversion rate doubled when queue exceeded 5 mi.</td>
</tr>
<tr>
<td>Travel times</td>
<td>71.6 % diverted</td>
</tr>
<tr>
<td></td>
<td>8 to 10 % diverted</td>
</tr>
<tr>
<td>Work Zone ITS</td>
<td>Study Findings</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Speed advisory</td>
<td>66% of drivers slowed down with overall speed reduction of 7 mph near work activity area. Speed variance also decreased.</td>
</tr>
<tr>
<td>Travel times</td>
<td>Crash rates declined and number of citations for moving violations also declined.</td>
</tr>
<tr>
<td>Queue information</td>
<td>Fatal crash rate was 50% lower than at control sites</td>
</tr>
<tr>
<td>Dynamic lane merge</td>
<td>Significant reduction in number of forced merges and dangerous merges</td>
</tr>
</tbody>
</table>

Past WZ ITS Deployments
Site Characteristics

- Congestion is frequent at the location
- Work zone results in high delays or crashes
- Alternative routes are available
- Demand is frequently at or above road capacity
Evaluation Framework

Performance measures selection

Operational measures
- Delay, Diversion, Queue length, Energy consumption, Emissions

Safety measures
- Crashes, Speed-based measures

Data collection

Traffic sensors
CCTV feeds
Probe data
Surveys
Crash database
Energy consumption
Emissions data

Benefit-cost analysis

Quantify benefits
- Reduction in delay, crash, emissions, energy
- Simulation or analytical methods
- AASHTO Red book guidance

Quantify costs
- Equipment, setup, operation, removal
- Unit cost estimates when project costs not available
Missouri Case Studies

• I-70 Blanchette Bridge Work Zone
  • Permanent Dynamic Message Signs
  • Traveler information and divert traffic to alternate routes

• I-44 Antire Road Work Zone
  • Permanent + Portable DMS, Bluetooth, Queue Warning
  • Traveler information and queue warning (safety)
Case Study Locations

I-70 Blanchette Bridge WZ
I-44 Antire Rd. WZ
• $63 million rehab. of a 54-year old bridge
• AADT ~121,000, ~12% trucks
• WB bridge over Missouri river closed for a year
• Lane reduction from 5 lanes to 3 lanes in both directions
• Two designated alternate routes – Rt. 364, Rt. 370
• Gateway Guide TMC

I-70 Blanchette Bridge WZ
I-70 Blanchette Bridge WZ
• Diversion rates
  • Traffic counts for mainline from permanent sensors
  • Ramp counts using portable sensors

• Diversion rate attributable to DMS
  • ITS was always on during work zone (no “Without ITS” data)
  • Traveler surveys

• Delay reduction benefits
  • Simulation model to simulate traffic flows

Evaluation of I-70 WZ ITS
## Traffic Diversion Rates

<table>
<thead>
<tr>
<th>Route</th>
<th>Time</th>
<th>Before WZ, Day 1 (10/24/12)</th>
<th>During WZ, Day 2 (11/7/12)</th>
<th>Diversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>EB I-70 to EB I-370</td>
<td>AM peak, 7-9am</td>
<td>30.6%</td>
<td>36.1%</td>
<td>+5.5%</td>
</tr>
<tr>
<td>EB I-70 to NB Rte 94</td>
<td>Off-peak, 1-2pm</td>
<td>7.7%</td>
<td>10.0%</td>
<td>+2.3%</td>
</tr>
<tr>
<td>EB I-70 to SB Rte 94</td>
<td></td>
<td>3.5%</td>
<td>4.9%</td>
<td>+1.4%</td>
</tr>
<tr>
<td>WB I-70 to NB Earth City Expwy</td>
<td>Off-peak, 1-2pm</td>
<td>11.9%</td>
<td>13.8%</td>
<td>+1.9%</td>
</tr>
<tr>
<td>WB I-70 to NB I-270</td>
<td>PM peak, 4-6pm</td>
<td>9.2%</td>
<td>11.9%</td>
<td>+2.7%</td>
</tr>
<tr>
<td>WB I-70 to SB I-270</td>
<td></td>
<td>22.2%</td>
<td>28.7%</td>
<td>+6.5%</td>
</tr>
<tr>
<td>NB I-270 to WB I-370</td>
<td></td>
<td>19.8%</td>
<td>24.5%</td>
<td>+4.7%</td>
</tr>
<tr>
<td>NB I-270 to Missouri Bottom Rd</td>
<td></td>
<td>5.0%</td>
<td>5.1%</td>
<td>+0.1%</td>
</tr>
<tr>
<td>SB I-270 to WB Rte 364</td>
<td></td>
<td>17.7%</td>
<td>21.9%</td>
<td>+4.2%</td>
</tr>
</tbody>
</table>
• 19-question web-based survey
• Questions focused on:
  • Commuter route choice before and during closure
  • Traveler information sources
  • Perceived delay
  • Value of travel time/incident messages on DMS
• Disseminated via MoDOT social media, newsletters, email
• 496 respondents in one month

• Two questions cross-referenced to find:
  “What percent of drivers that diverted to an alternate route did that due to ITS?”
Assessing Delay Reduction

VISSIM Simulation Model

Assessing Delay Reduction
• Road resurfacing for 140 days
• AADT ~69,000, ~12% trucks
• No alternate routes due to rural setting
• Lane reduction
  • 3 lanes to 2 lanes in both directions
  • Exception: 3pm to 7pm all 3 lanes available for WB
I-44 Antire Road WZ
• Reduction in crashes
  • Crash data from MoDOT database
  • Again, “Without ITS” data not available
  • One study showed a 13.8% reduction in queue related crashes due to WZ ITS

• Crash reduction benefits
  • Benefits quantified using AASHTO Redbook values

Evaluation of I-44 WZ ITS
Benefit-Cost Analysis

- Total costs include: cost of equipment, cost of operation, and cost of set up
- Total benefits include: delay reduction benefits and crash reduction benefits.

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Benefits</th>
<th>Costs</th>
<th>B/C Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-70</td>
<td>$407,694</td>
<td>$198,530</td>
<td>2.1:1</td>
</tr>
<tr>
<td>I-44</td>
<td>$345,900</td>
<td>$106,700</td>
<td>3.2:1</td>
</tr>
</tbody>
</table>
• Performance “without ITS” is required to quantify WZ ITS benefits
  • Has been the missing component or less accurate part
• Obtaining “without ITS” data
  • Control site (s)
  • Not use ITS for a few days when WZ is active
  • Traveler surveys
• Evaluations are data intensive
  • Private sector data to supplement other data
• Emissions and fuel consumption data challenges
• Evaluation tools, information accessible to practitioners
  • Unit costs, rates, parameters, etc
• How to leverage and evaluate newer ITS technology to improve WZ operations and safety?
  • Connected Vehicle Technology
  • Autonomous Vehicles

Challenges and Opportunities
• Synthesis of past WZ ITS deployments
  • Collectively, what does existing research tell us about effectiveness of WZ ITS

• A framework for future WZ ITS evaluations

• Case studies illustrating framework use

• Lessons learned and future opportunities

Summary
Acknowledgments

- Missouri DOT Staff
  - Dan Smith, Jon Nelson, Linda Wilson, Tom Blair, Gateway Guide Staff, Ryan Pierce
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  - Keith Knapp, Tom McDonald
- Mid-America Transportation Center

• FHWA WZ Mobility and Safety Program
  • ITS and Technology - [http://www.ops.fhwa.dot.gov/Wz/its/index.htm#its](http://www.ops.fhwa.dot.gov/Wz/its/index.htm#its)

• The National WZ Safety Information Clearinghouse
  [http://wzsafety.tamu.edu/](http://wzsafety.tamu.edu/)

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**Final Report and Other Resources**