Perspectives on Resilience: A Framework for Transportation Agencies

Michael D. Meyer, Senior Advisor
WSP USA Inc.

Key Foundations for Resilience Perspectives

- NCHRP 20-59(54) Transportation System Resilience: Research Roadmap and White Papers
- NCHRP 20-59(55) Transportation System Resilience: CEO Primer & Engagement
- NCHRP 20-117 Deploying Transportation Resilience Practices in State DOTs

... And many more Cooperative Research, USDOT, NAS, and state DOT research projects
Why should we care?

• Transportation sector third most vulnerable sector to cyberattacks

• Worldwide, transportation is the #1 target of terrorists

• Future climate and extreme weather conditions

Why should we care?

• Disruptions to transportation system

• Increasingly interconnected world

• Highly visible – both for impacts and DOT leaders
Some Key Observations

Observation 1

Resilience often has different meanings to different people
Recommended List of Disruptive Events for MDOT

- Natural Hazards
  - Extreme Cold
  - Extreme Heat
  - Windstorms
  - Wildfires
  - Riverine/Fluvial Flooding
  - Landslides
  - Snow/Ice Storms

- Man-made Hazards
  - Terrorism
  - Technological/Engineering Failure
  - Cyber Security
  - Societal Disruptions

- Financial
  - Reduced Federal funding
  - Increased Maintenance Costs

Risks “Levels” to Consider

<table>
<thead>
<tr>
<th>Levels for Risk</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency level</td>
<td>Affects mission, vision, and overall results of the asset management program</td>
<td>Politics, Public perception/reputation, Levels of available revenue (e.g., State and federal funding are significantly reduced)</td>
</tr>
<tr>
<td>Programmatic level</td>
<td>Affects the ability to deliver projects and meet targets within a program</td>
<td>Project delivery risks, Revenue uncertainties, Cost-estimating processes, Revenue and inflation projection inaccuracies, Construction cost variations, Materials price volatility, Data quality, Retirements</td>
</tr>
<tr>
<td>Project/Asset level</td>
<td>Affects scope, cost, schedule, and quality of projects</td>
<td>Hazardous materials/Geology, Environmental issues, Right-of-way issues, Utilities, Project development timeline/delays, Scope growth, Cost overruns, Project delays, Damaging weather events</td>
</tr>
</tbody>
</table>
Defining Resilience

“...the ability to minimize the costs of a disaster, to return to a state as good as or better than the status quo ante, and to do so in the shortest feasible time.”

— NIST, Disaster Resilience: A Guide to the Literature, 2010

“the ability to prepare and plan for, absorb, recover from, or more successfully adapt to adverse events.”

— AASHTOScotSem, 2012

<table>
<thead>
<tr>
<th>Transportation Systems Resilience</th>
<th>Operational Resilience</th>
<th>Organizational Resilience</th>
</tr>
</thead>
</table>
| The ability to prepare and plan for, absorb, recover from, or more successfully adapt to adverse events. | The ability to maintain or restore normal traffic operations under a range of conditions. The ability to maintain or restore mission-critical business processes. | People Capability Maturity Model Designed to:  
  - Improve the quality of products and services,  
  - Reduce cycle times  
  - Improve organizations’ abilities to respond to rapidly changing competitive conditions |
Recommended Consequences for MDOT

Categories:
• Reputation
• Health and Safety
• Service Delivery
• Financial
• Transportation Users

Consequence Rating for that Disruption/Event

Weighted for each Disruption/Event

Observation 2

Resilience should be part of every functional area in a DOT
Observation 3

Resilience should be part of the life cycle of assets, especially those considered most critical.

Observation 4

A resilience strategy for a DOT is adaptive, collaborative, communications-focused and results-oriented.
### Observation 5

A DOT can systematically identify areas of risk and develop risk mitigation strategies.

### Building a Resilience Framework

<table>
<thead>
<tr>
<th>Current Status</th>
<th>Analysis</th>
<th>Apply</th>
<th>Engrain</th>
</tr>
</thead>
</table>
| • Existing practices  
• Organization  
• Communications  
• Early wins | • Threat assessment  
• Potential impacts  
• Identify priorities | • Risk analysis  
• Resilient strategies  
• Risk-based asset management  
• Comprehensive emergency response  
• Develop partnerships | • Performance management  
• Resilient agency protocols  
• Practice |

Adaptive  
Collaborative  
Communications-focused  
Results-oriented
Illinois DOT Resiliency Entry Points

- **Safety** – Resiliency involves providing a safer transportation system for system users, while also reducing the dangers for first responders
- **Mobility** – Resiliency involves minimizing disruptions which can impact the user experience, causing delays and/or major inconveniences
- **Economy** – Resiliency involves minimizing the socioeconomic costs of disruptions caused by impairment of travel/goods movement
- **Stewardship** – Resiliency involves minimizing long-term costs for infrastructure repair/maintenance
Caltrans

PHASES FOR ACHIEVING RESILIENCY

California has been a national leader in responding to extreme events and climate change events. The objectives of this study are to ensure the resilience of infrastructure systems and the community. This study is focused on identifying and evaluating the potential for emerging technologies and innovative approaches to improve the resilience of transportation infrastructure systems. The study aims to identify and evaluate the potential for emerging technologies and innovative approaches to improve the resilience of transportation infrastructure systems. The study aims to identify and evaluate the potential for emerging technologies and innovative approaches to improve the resilience of transportation infrastructure systems. The study aims to identify and evaluate the potential for emerging technologies and innovative approaches to improve the resilience of transportation infrastructure systems. The study aims to identify and evaluate the potential for emerging technologies and innovative approaches to improve the resilience of transportation infrastructure systems.

SCOPE OF THIS STUDY

1. Identify key challenges and opportunities for enhancing the resilience of transportation systems.
2. Develop and evaluate potential strategies for enhancing the resilience of transportation systems.
3. Identify potential new technologies and innovative approaches.
4. Evaluate the potential impacts of various strategies and technologies on transportation systems.

RESILIENCE RESOURCES

- Transportation Planning:
  - Existing planning tools and techniques:
    - Risk assessments
    - Vulnerability assessments
    - Resilience assessments
  - New planning tools and techniques:
    - Risk-based planning
    - Resilience-based planning
    - Integrated risk and resilience planning

- Transportation Operations:
  - Existing operations and management:
    - Traffic operations
    - Public transportation systems
    - Freight transportation systems
  - New operations and management:
    - Resilient traffic operations
    - Resilient public transportation systems
    - Resilient freight transportation systems

- Transportation Infrastructure:
  - Existing infrastructure:
    - Bridge systems
    - Roadway systems
    - Rail systems
  - New infrastructure:
    - Resilient bridge systems
    - Resilient roadway systems
    - Resilient rail systems

- Transportation Technology:
  - Existing technology:
    - Information and communication technology
    - Transportation management technology
    - Transportation safety technology
  - New technology:
    - Resilient information and communication technology
    - Resilient transportation management technology
    - Resilient transportation safety technology

- Transportation Policy and Governance:
  - Existing policies and governance:
    - Transportation policies
    - Transportation governance structures
  - New policies and governance:
    - Resilient transportation policies
    - Resilient transportation governance structures

- Transportation Finance:
  - Existing finance:
    - Transportation funding sources
    - Transportation funding mechanisms
  - New finance:
    - Resilient transportation funding sources
    - Resilient transportation funding mechanisms

- Transportation Education and Training:
  - Existing education and training:
    - Transportation education programs
    - Transportation training programs
  - New education and training:
    - Resilient transportation education programs
    - Resilient transportation training programs

- Transportation Research:
  - Existing research:
    - Transportation research programs
    - Transportation research projects
  - New research:
    - Resilient transportation research programs
    - Resilient transportation research projects

- Transportation Standards and Guidelines:
  - Existing standards and guidelines:
    - Transportation standards
    - Transportation guidelines
  - New standards and guidelines:
    - Resilient transportation standards
    - Resilient transportation guidelines

- Transportation Collaboration and Partnership:
  - Existing collaboration and partnership:
    - Transportation collaboration agreements
    - Transportation partnership agreements
  - New collaboration and partnership:
    - Resilient transportation collaboration agreements
    - Resilient transportation partnership agreements

- Transportation Technology and Innovation:
  - Existing technology and innovation:
    - Transportation technology and innovation
  - New technology and innovation:
    - Resilient transportation technology and innovation

- Transportation Infrastructure and Network:
  - Existing infrastructure and network:
    - Transportation infrastructure
    - Transportation network
  - New infrastructure and network:
    - Resilient transportation infrastructure
    - Resilient transportation network
MNDOT....
Included in Sustainability Focus

“Climate adaptation: Design, construct, operate, and maintain infrastructure to be resilient to the changing climate.”

Statewide Transportation Plan

1. Safety: “Work with emergency medical and trauma services to reduce response time and increase survivability.”

2. Safety: “Collaborate with local, regional, state and federal planning efforts to ensure efficient and coordinated response to special, emergency and disaster events.”

3. Safety: “Enhance and maintain emergency communications infrastructure across the state.”

MNDOT

4. Critical Connections: “Provide greater access to destinations and more efficient, affordable and reliable movement of goods and people throughout the Twin Cities metropolitan area.”

5. System Stewardship: “Proactively identify risks to the transportation system and surrounding communities in order to prioritize mitigation and response activities.”

6. System Stewardship: “Support regional approaches to mitigating identified risks to the transportation system and surrounding communities.”

7. System Stewardship: “Use recovery efforts to reduce system vulnerabilities.”

8. System Stewardship: “Conduct regular inspections of transportation infrastructure, facilities and equipment to monitor conditions and identify risks.”
MNDOT – Asset Management

“Identify vulnerabilities and assess risks to the transportation system.”

“As risks are identified, MnDOT will evaluate strategies to reduce or eliminate vulnerabilities.”

“MnDOT will also develop better methods to track and report investments to respond to identified system risks.”

CDOT Risk and Resilience

August 2016: I-70 Risk and Resilience Pilot
- Completed November 2017
CDOT Risk and Resilience

**TOTAL RISK FROM ALL THREATS PER LANE MILE**

<table>
<thead>
<tr>
<th>Segment</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$249,625</td>
</tr>
<tr>
<td>B</td>
<td>$281,027</td>
</tr>
<tr>
<td>C</td>
<td>$98,816</td>
</tr>
<tr>
<td>D</td>
<td>$58,419</td>
</tr>
<tr>
<td>E</td>
<td>$137,718</td>
</tr>
<tr>
<td>F</td>
<td>$220,393</td>
</tr>
<tr>
<td>G</td>
<td>$5,997</td>
</tr>
<tr>
<td>H</td>
<td>$6,573</td>
</tr>
<tr>
<td>I</td>
<td>$7,316</td>
</tr>
<tr>
<td>J</td>
<td>$3,076</td>
</tr>
<tr>
<td>K</td>
<td>$5,917</td>
</tr>
<tr>
<td>L</td>
<td>$4,491</td>
</tr>
</tbody>
</table>

**SEGMENT CRITICALITY SCORE**

Something Else To Think About

What does it mean to foster a resilience-oriented agency culture?
What are Influence Factors for Resilience?

• Have you assessed current resilience practices?
• Have you organized for success?
• Have you developed an internal and external communications strategy/plan?
• Have you developed an emergency response strategy/plan (that is, actions to be taken during the disruption)? .....Some early wins
• Have you made a systematic and comprehensive effort to identify potential hazards and threats to the transportation system?

What are Influence Factors for Resilience?

• Have you made a systematic and comprehensive effort to understand the impacts of these potential hazards and threats on transportation system performance and to your agency’s ability to operate and manage the system?
• Have you identified priorities for more detailed risk assessments of mandate-critical functional areas and/or facilities?
• Have you undertaken detailed risk assessments of these priority facilities, assets or services?
• Have you implemented resilience-oriented projects and strategies?
What are Influence Factors for Resilience?

• Have you incorporated resilience-oriented analysis and strategies into your asset management program?

• Have you identified performance measures related to agency-oriented resilience efforts and to measuring transportation system resilience?

• Have you mainstreamed resilience as a concept and with specific actions into agency practices?

Workshop 1080
“Resilience, Safety, and Security of Bridges and Tunnels: U.S. and International Topics”

Sunday, January 13, 2019, 1:30PM – 4:30PM in Room 203 of the Convention Center

“There are many concern regarding robustness, resilience, safety and security concerns of national and International interest regarding bridges and tunnels. Past bridge collapses, bridge and tunnel fires, and other extreme events reveal the vulnerabilities of transportation infrastructure. This workshop provides an update on national and international bridge and tunnel activities to prevent or lessen the impact of natural and manmade events such as these in the future as well as providing a forum for discussion of challenges facing owners.”
Moderator: Jeffrey Western

Resilience of Bridges and Tunnels – Harry Capers / Jeff Western
Tunnel Life Safety: FHWA Global Benchmarking / International Perspectives - Steve Ernst, SME
Fire Engineering is About Protecting Life - Conrad Stacey, StaceyAgnew, Australia
Safety, Security and Resilience Considerations for the Alaskan Way Highway Tunnel – Bijan Khalegi, WashDOT
Security of Bridges and Tunnels – David Cooper, TSA
Evaluation of Bridge Resilience - Rade Hajdin, University of Belgrade, Serbia
Tools for assessing the Cyber Security of Tunnel Control Centres - Jürgen Peter Krieger, Federal Highway Research Institute, Germany
Safety, Security, and Resilience of the Nation’s Bridges - Vincent P. Chiarito, FHWA
FHWA Tunnel Efforts - Bill Bergeson, FHWA

Thank You