Quantifying Utility Risk in Transportation Project Development

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Utilities Impacts in Transportation

- Why are they in our Right-of-Way?
- Tax Payers = Rate Payers; In public interest
- Design Costs are 10% of Construction Costs
- Utility Costs are 10% of Design Costs
- Utility Costs are 0.1% of Construction Costs
- Utility issues increase construction costs by 3.16% (Goodrum, et. al., 2010)
Utilities Risk in Project Development

3rd Leading Cause of Project Delays

- Weather: 2.99%
- Utilities/3rd parties: 8.96%
- Materials, QA, Fabrication: 10.45%
- Site Conditions, Extra Work, Env. Mitigation, Quantity Adjustments: 14.93%
- Other - Contractor Means and Methods, Records: 13.43%
- Design: 61.19%
- Incentives: 20.90%

Source: 2018 AASHTO CRUO Annual Meeting FHWA Presentation, Julie Johnston
Can we quantifiably estimate utility-related risks to highway projects?

- Otherwise we address all projects similarly
  - Inefficient use of resources

- Projects and utility facilities have varying risk dimensions and attributes
  - Complexity
  - Costs
  - Time
  - Safety
  - Location Uncertainty
  - Data Availability
  - Operational Concerns
  - Structural Concerns
What is Utility Risk?

• Within the constructs of this work...
  • Project Development
  • Time
  • Cost
  • Complexity in Coordination
    • Considered a function related to the number of utility agreements
Quantifying Utility Related Risks

• Research Approach
  • Collected & analyzed KYTC project data
    • 13,856 projects (1989-2014)
    • *Data Cautions! Review with SMEs*
  • Quantified risk according to:
    • Time required for utility relocations/clearance (743 records)
    • Complexity of utilities involved (1,503 records)
    • Utility relocation cost (1,878 records)
Quantifying Utility Related Risks

- Time Associated Risk Factors (743 records)
  - Utility Clearance Date versus Phase Authorization Date
  - Utility Relocations Completed Date versus Phase Authorization Date
  - Utility Agreements Completed Date versus Phase Authorization Date

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Description for Utility Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (1)</td>
<td>Less than 365 days (1 year)</td>
</tr>
<tr>
<td>Medium (2)</td>
<td>Between 365 and 1095 days (3 years)</td>
</tr>
<tr>
<td>High (3)</td>
<td>Greater than 1095 days</td>
</tr>
</tbody>
</table>
Quantifying Utility Related Risks

- Complexity Associated Risk Factors (1,503 records)
- More Abstract Measure

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Number of Utilities Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (1)</td>
<td>Less than 3</td>
</tr>
<tr>
<td>Medium (2)</td>
<td>Between 3 and 6</td>
</tr>
<tr>
<td>High (3)</td>
<td>Greater than 6</td>
</tr>
</tbody>
</table>
Quantifying Utility Related Risks

- Cost Associated Risk Factors (1,878 records)

<table>
<thead>
<tr>
<th>Descriptive Statistic</th>
<th>Utility Phase Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>$541,305</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>$962,140</td>
</tr>
<tr>
<td>Minimum</td>
<td>$0</td>
</tr>
<tr>
<td>Maximum</td>
<td>$9,717,856</td>
</tr>
<tr>
<td>First Quartile</td>
<td>$50,000</td>
</tr>
<tr>
<td>Median</td>
<td>$150,000</td>
</tr>
<tr>
<td>Third Quartile</td>
<td>$586,500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Utility Phase Authorization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (1)</td>
<td>Less than $300,000</td>
</tr>
<tr>
<td>Medium (2)</td>
<td>Between $300,000 and $600,000</td>
</tr>
<tr>
<td>High (3)</td>
<td>Greater than $600,000</td>
</tr>
</tbody>
</table>
Quantifying Utility Related Risks

- Combined Risk Scores

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Number of Projects Per Risk Level (1,966 Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (1)</td>
<td>836 (42.5%)</td>
</tr>
<tr>
<td>Medium (2)</td>
<td>745 (37.9%)</td>
</tr>
<tr>
<td>High (3)</td>
<td>385 (19.6%)</td>
</tr>
</tbody>
</table>
Utility Risk Model

- Research Analysis $\sim$ Risk Model
  - Multiple Linear Regression
  - Backward selection to a parsimonious model
  - R-squared 0.84; p-value <0.0001
  - Validation through sample projects and KYTC review

$$\text{Risk} = 1.14 - 0.02^{\ast}\text{District} + \text{Project Type (Categorical Variable Range)} + 0.02^{\ast}\text{Phase Authorization (in$100,000)} + 0.13^{\ast}\text{Number of Utilities Involved}$$
We can predict where problems will be, now what?

• Research Approach ~ *Practice Alignment*
  • Practice collection
    • Literature review (11 DOT process manuals)
    • Nationwide survey (84% response rate; 42 DOTs)
    • Kentucky survey and interviews (KYTC Task Force)

• Prioritization
  • Utility company feedback (29 respondents)
  • DOT interviews & Case studies (6 DOTs)
Best Practices to Mitigate Utility Risk

- Research Analysis ~ *Practice Alignment*
  - Aligned best practices to risk levels
  - SMEs validated practice alignment
    - Utility company interviews (4 companies)
    - Kentucky Transportation Cabinet subject-matter expert review (Central Office and District)
# Best Practices to Mitigate Utility Risk

<table>
<thead>
<tr>
<th>Tool</th>
<th>Appropriate Risk Level</th>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Utility Involvement in Design</td>
<td>1,2,3</td>
<td>• Early incorporation of utility knowledge in design process</td>
<td>• Level of effort increases for utility staff early in project</td>
<td>• Time savings from better coordination</td>
<td>• More involvement could slow early design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Early identification of potential utility issues</td>
<td></td>
<td>• Money savings form avoiding potential issues</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Better coordinated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training project managers and other design personnel on utility issues</td>
<td>1,2,3</td>
<td>• Sufficient knowledge with regards to utility relocation</td>
<td>• Level of effort increases for manager and design personnel</td>
<td>• Time and cost saving from better design</td>
<td>• Spending more cost and time for training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Better and early identification of</td>
<td></td>
<td>• Time and cost saving from better</td>
<td></td>
</tr>
</tbody>
</table>
## Risk Support Tool

- **Implementation**

### Utility Risk Assignment Worksheet

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<th>Strengths</th>
<th>Weaknesses</th>
<th>Opportunity</th>
</tr>
</thead>
</table>
| Early Utility Involvement in Design     | • Early Incorporate utility knowledge in design process  
• Early identification of potential utility issues  
• Better coordinated                   | • Level of effort increases for utility staff early in project             | • Time savings  
• Money issues                           |
| Training project managers and other    | • Sufficient knowledge with regards to utility relocation  
• Better and early identification of potential utility issue              | • Level of effort increases for manager and design personnel             | • Time savings  
• Better knowledge                      |                             | • Time saving  
• Less reliance                          |
| Training consultant and utility owner   | • Sufficient knowledge with regards to utility relocation                 | • Level of effort increases for consultant and utility owner personnel | • More reliance  
• Better coordination from more          |                             | • More time  
• More cost                              |                             | • Early completion             |
| Early utility cost estimation based on  | • Better budgeting                                                        | • Time & effort in development                                          | • Time savings  
worst assumption                         |                             | • Cost savings                |                                |
| Using technology tools such as Google   | • More effective tools for planning                                       | • Lack of enough experts                                                | • Cost savings  
Earth, GIS in the planning stage         |                             | • Personnel training         |                                |
|                                        |                                                                           |                                                                             |                                |
Conclusions

• Quantitative assessment of utility-related risk
  • Prioritize utility needs and resources

• Alignment & strategic application of best practices
  • Minimize & mitigate utility related issues

• Utility process data collection and management improvements needed—Utility Conflict Management systems
Questions?

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