IOWA STATE UNIVERSITY
Civil, Construction and Environmental Engineering

Quantifying Utility Risk in Transportation Project Development

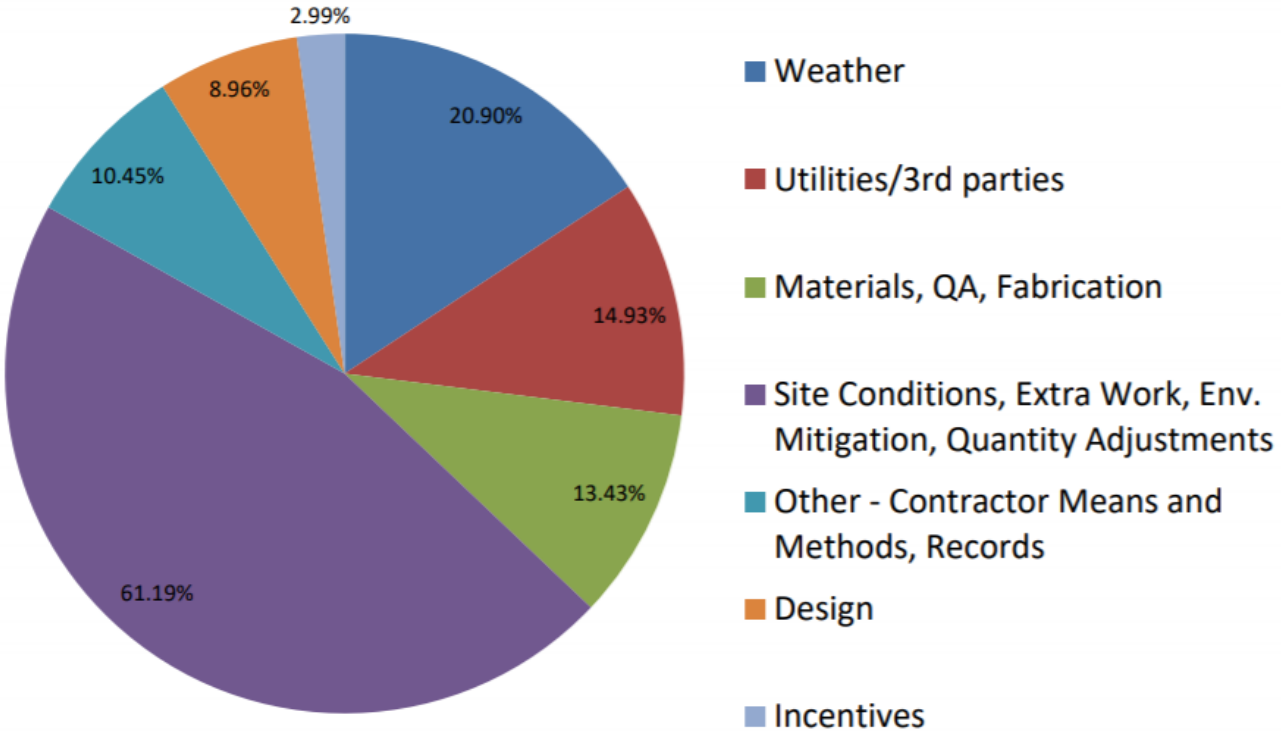
Roy E. Sturgill, Jr., Ph.D., P.E. (KY)
Tim Taylor, Ph.D., P.E.—University of Kentucky
Gabe Dadi, Ph.D., P.E.—University of Kentucky

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



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

Risk Level	Description for Utility Duration
Low (1)	Less than 365 days (1 year)
Medium (2)	Between 365 and 1095 days (3 years)
High (3)	Greater than 1095 days

Quantifying Utility Related Risks

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

Risk Level	Number of Utilities Involved
Low (1)	Less than 3
Medium (2)	Between 3 and 6
High (3)	Greater than 6

Quantifying Utility Related Risks

- Cost Associated Risk Factors (1,878 records)

Descriptive Statistic	Utility Phase Value
Average	$541,305
Standard Deviation	$962,140
Minimum	$0
Maximum	$9,717,856
First Quartile	$50,000
Median	$150,000
Third Quartile	$586,500

Risk Level	Utility Phase Authorization
Low (1)	Less than $300,000
Medium (2)	Between $300,000 and $600,000
High (3)	Greater than $600,000

Quantifying Utility Related Risks

- Combined Risk Scores

Risk Level	Number of Projects Per Risk Level (1,966 Total)
Low (1)	836 (42.5%)
Medium (2)	745 (37.9%)
High (3)	385 (19.6%)

Utility Risk Model

- Research Analysis ~ *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

$$\textbf{\textit{Risk}} = 1.14 - 0.02 * \text{District} + \text{Project Type (Categorical Variable Range)} + 0.02 * \text{Phase Authorization (in \$100,000)} + 0.13 * \text{Number of Utilities Involved}$$

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

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

Risk Support Tool

- Implementation

Utility Risk Assignment Worksheet

Tool	Strengths	Weaknesses	Opportuni
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 s • Mone issues
Training project managers and other design personnel on utility issues	• 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 a • Time a managem • Better knowledg
Training consultant and utility owner personnel	• Sufficient knowledge with regards to utility relocation	• Level of effort increases for consultant and utility owner personnel	• Less r • More
Early utility cost estimation based on worst assumption	• Better budgeting	• Time & effort in development	• Early scope
Using technology tools such as Google Earth, GIS in the planning stage	• More effective tools for planning	• Lack of enough experts • Personnel training	• Time s • Cost s

personnel on utility issues | potential utility issue | design personnel | management

• Better coordination from more

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?

Sturgill@iastate.edu