P3 Project Risk Assessment

P3-VALUE Webinar
March 7, 2015
Instructors

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Office of Innovative Program Delivery

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IMG Rebel
P3-VALUE 2.0 Webinars

- **P3**: Public Private Partnership
- **P3-VALUE 2.0**: Analytical tool to help practitioners understand processes used to quantitatively evaluate P3 options
- This is one of a series of webinars on P3-VALUE
  - P3 Evaluation Overview (January 25, 2016)
  - Value for Money Analysis (February 8, 2016)
    - Value for Money Exercise (Feb. 16, 2016)
  - Project Delivery Benefit-Cost Analysis (Feb. 22)
    - Project Delivery BCA Exercise (Feb. 29, 2016)
  - **Risk Valuation (today)**
  - Financial Viability Assessment
Webinar Outline

Part 1  Categorizing Risk
Part 2  Risk Management Process
Part 3  Pure Risk Assessment
Part 4  Lifecycle Performance and Revenue Uncertainty Risk Assessment
Part 5  Risk Allocation
Part 6  Using P3-VALUE 2.0 for Risk Assessment

Summary
Webinar Objectives

After taking this course you should be able to:

- Categorize P3 risks
- List the steps in the risk management process
- Explain the methods for quantifying and monetizing various type of risks
- Describe the risk allocation process
- Use P3-VALUE 2.0 to perform risk assessment
Part 1

Categorizing P3 Risks
Purpose of Risk Assessment

- To calculate value of risks
- To design *draft agreement* for RFP
- To assist in *negotiation* with bidders
- To develop *risk management plans*
Financial Impacts of Project Risks

- **Costs**
  - Increase in expenses
    - Construction
    - O&M
    - Major maintenance

- **Delays**
  - Effects of delays
    - Additional costs
    - Cost escalation
    - Lost revenues
    - NPV effect

- **Revenues**
  - Loss in revenues
    - Delay: foregone toll/AP revenues
    - Traffic: Lower than expected revenues
Categories of Risk

- Risks
  - Exogenous Risks
  - Endogenous Risks
    - Decision Uncertainties
  - Project Risks
  - Process Risks
    - Systematic Risks
      - Lifecycle Performance Risk
    - Non-Systematic Risks
      - Pure Risks
      - Regular Uncertainties
        - Base Variability
P3-VALUE 2.0 Project Risk Categories

- **Base Variability**
  Example: Uncertainty in volume of asphalt

- **Pure Risks**
  Example: Accident at construction site, causing cost overrun and/or delays

- **Lifecycle Performance Risks & Revenue Uncertainty**
  Example: Conflicts between DB and O&M contractors, supervening events exceeding liability caps, inflation, T&R risk (for toll concessions)
Valuing Base Variability

- Typically a percentage of costs (+ or - variation)
- May differ by project phase
- Reflects the uncertainty in cost estimates – will reduce as the design level becomes more detailed
- P3-VALUE 2.0 uses a factor (percentage of base cost) to estimate cost impact
- Example:
  - Base variability: 20% of construction cost
  - Construction cost: $200M
  - Value of base variability: 20% X $200M = $40M
Who Bears Project Risks in a P3?

Includes both systematic and some non-systematic risks

- Inflation risk
- Interest rate risk
- Performance risk
- Integration risk
- Toll revenue risk

- Construction risk
- Operations risk

- Public Agency
- Special Purpose Vehicle (SPV)
- Lenders (Bond Holders/Banks)
- Equity Providers
- Design-Build consortium
- Maintenance contractor
- Operator
- Subcontractors
Risk over Project Life

- Risk
- Development
- Construction
- Transition
- Operation
- Greenfield

Time
Audience Feedback

True or False

- All project risks are pushed down to subcontractors of the concessionaire.
Questions?

Submit a question using the chat box
Part 2

Risk Management Process
Risk Management Process Overview

1. Identification

2. Assessment & Analysis

3. Risk Response Planning

4. Allocation

5. Monitoring & Control
1. Risk Identification

Risks:
- Threats
- Opportunities

Risk Workshops
- Who?
  - Facilitator
  - Subject matter experts
- What tools are used?
  - Risk checklist
  - Risk register
2. Risk Assessment

- Probability
- Potential consequences
  - Cost
  - Schedule
  - Scope/Quality
  - Revenue
- Value
3. Risk Response Planning

Risk Response Strategies

- Avoid
- Mitigate
- Transfer/Share
- Accept
4. Risk Allocation

- Transfer or retain
- Share
5. Risk Monitoring & Control

- Performance metrics to monitor risk
- Understand P3 risk management provisions
- Avoid taking back transferred risks
- Validate previous risk identification, risk assessment, and risk response planning
Audience Feedback

True or False

- The probability and potential consequences of a specific risk must be quantified in order to estimate its cost impact.
Questions?

Submit a question using the chat box
Part 3

Pure Risk Assessment
Pure Risk Assessment Process

Qualitative Assessment
What is the risk rating?

Medium, high, and very high-rated risks

Quantitative Assessment
What is the probability and potential impacts of the risk occurring?

Formula-based calculation

Monte Carlo simulation

Results
Aggregate cost, delay or revenue impact

Aggregate Risks

Discard Risks

Very low and low-rated risks
Qualitative Assessment

- **Probability of risk occurrence**
  - Very low
  - Low
  - Medium
  - High
  - Very high

- **Scale of impact if risk occurs**
  - Very low
  - Low
  - Medium
  - High
  - Very high
## Qualitative Assessment Matrix

### Example

#### Representative Cost Impact Assessment Matrix

<table>
<thead>
<tr>
<th>Scale</th>
<th>5 - &gt; 70%</th>
<th>4 - 40% - 70%</th>
<th>3 - 20% - 40%</th>
<th>2 - 5% - 20%</th>
<th>1 - 0% - 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Probability</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Probability</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Probability</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Probability</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

#### Representative Schedule Impact Assessment Matrix

<table>
<thead>
<tr>
<th>Scale</th>
<th>&gt; 365 days</th>
<th>120 - 365 days</th>
<th>30 - 120 days</th>
<th>7 - 30 days</th>
<th>&lt; 7 days</th>
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<tbody>
<tr>
<td>Probability</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
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<tr>
<td>Probability</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Probability</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Probability</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Probability</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
Quantitative Assessment

- Probability of risk occurrence
  - % probability (0% - 100%)
- Scale of impact if risk occurs
  - Dollar amount or number of days of delay
Valuing Pure Risks (Formula-Based)

- Risk Value = Probability X Impact (distribution)
- Example for *uniform* probabilistic impact distribution:
  - Probability of occurrence: 10%
  - Minimum impact: $2M
  - Maximum impact: $4M
  - Value = 10% x ½ x ($2M + $4M) = $0.3M
Valuing Pure Risks (Formula-Based)

- Risk Value = Probability X Impact (distribution)
- Example for *triangular* impact distribution:
  - Probability of occurrence: 10%
  - Minimum impact: $2M
  - Maximum impact: $4M
  - Most likely impact = $3.5
  - Value = 10% x ($2M + 3.5 + $4M)/3 = $0.32M
Aggregate of Pure Risks

- Central limit theorem can be used if pure risks are independent:
  - Distribution of the sum of a sufficiently large number of independent random variables is approximately normal
- To apply central limit theory, variance and mean value of each individual risk must be calculated and added
Central Limit Theorem Applied

Example using uniform risk distributions (P3-VALUE 2.0)

<table>
<thead>
<tr>
<th>Risk Item</th>
<th>Probability A</th>
<th>Most likely Impact B</th>
<th>Most likely value C = A x B</th>
<th>Minimum value D</th>
<th>Maximum value E</th>
<th>Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk 1</td>
<td>20%</td>
<td>$10,000k</td>
<td>$2,000k</td>
<td>-20%</td>
<td>+50%</td>
<td>Uniform</td>
</tr>
<tr>
<td>Risk 2</td>
<td>25%</td>
<td>$4,000k</td>
<td>$1,000k</td>
<td>-20%</td>
<td>+50%</td>
<td>Uniform</td>
</tr>
<tr>
<td>Risk 3</td>
<td>50%</td>
<td>$4,000k</td>
<td>$2,000k</td>
<td>-20%</td>
<td>+50%</td>
<td>Uniform</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Item</th>
<th>Minimum value F = C – D%</th>
<th>Maximum value G = C + E%</th>
<th>Mean value* H = ( \frac{1}{2} \times (F + G) )</th>
<th>Variance* I = ( \frac{(G – F)^2}{12} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk 1</td>
<td>$1,600k</td>
<td>$3,000k</td>
<td>$2,300k</td>
<td>$163,333k</td>
</tr>
<tr>
<td>Risk 2</td>
<td>$800k</td>
<td>$1,500k</td>
<td>$1,150k</td>
<td>$40,833k</td>
</tr>
<tr>
<td>Risk 3</td>
<td>$1,600k</td>
<td>$3,000k</td>
<td>$2,300k</td>
<td>$163,333k</td>
</tr>
</tbody>
</table>

| Total     | $4,000k                  | $7,500k                  | $5,750k                         | $376,500k       |

- Mean value: $5,750k, standard deviation of $606k
- Using Excel NORMINV function, P70 risk value: $6,068k
Monte Carlo simulation

- Simulation of large number of scenarios based on probabilities of risk occurrence and probability distribution of magnitude of impact
- Result is a probability distribution of aggregate risk value
- Provides estimates at confidence levels
True or False

- The aggregate impact of pure risks on costs may be estimated either by using a formula-based method or by using Monte Carlo simulation.
Questions?

Submit a question using the chat box
Part 4

Assessment of Lifecycle Performance Risk and Revenue Uncertainty Adjustment
Valuing Lifecycle Performance Risks

Ways to value lifecycle performance risk

- Use information available to Agency on lifecycle performance risk costs/cash flows
- Use market-based P3 financing conditions as a proxy to determine the value of lifecycle performance risk
Valuing Lifecycle Performance Risks

Market-based valuation:

- Calculate NPV of cost cash flows*, excluding financing:
  
  A. Using a market-based weighted average cost of capital (WACC) that excludes revenue risk (Availability Payment WACC)
  
  B. Using project risk-free discount rate

- Calculate difference in NPVs ($\Delta = A - B$)

*Use PSC cash flows for PSC lifecycle performance risk, and P3 cash flows for P3 lifecycle performance risk (used only in PDBCA and risk outputs)
Lifecycle Performance Risk Valuation

Calculated lifecycle performance risk premium (annuity with NPV = \( \Delta \))

\[ A = \text{NPV @ market-based WACC} \]

\[ B = \text{NPV @ project risk-free discount rate} \]

\[ \Delta = A - B = \text{NPV of lifecycle performance risk} \]

Costs (capex, O&M, major maintenance, etc.)
Valuing Revenue Uncertainty

Ways to value revenue uncertainty

- Apply percentage haircut to P50 traffic/revenues
- Use market-based P3 financing conditions as a proxy to determine the value of revenue uncertainty
Valuing Revenue Uncertainty

Market-based valuation:

- Calculate NPV of revenue and cost cash flows, excluding financing:
  
  C. Using a market-based weighted average cost of capital (WACC) that includes revenue risk
  D. Using project risk-free discount rate

- Calculate difference in NPVs ($\Delta = C - D$), which equals the lifecycle performance risk and revenue uncertainty adjustment combined

- NPV of revenue risk is the difference between this $\Delta$ and the lifecycle performance risk calculated previously
Revenue Uncertainty Adjustment

\[ C = \text{NPV} @ \text{market-based WACC}_{\text{Toll Concession}} \]

\[ D = \text{NPV} @ \text{project risk-free discount rate} \]

\[ \Delta = C - D = \text{NPV of lifecycle performance risk & revenue uncertainty adjustment} \]
# Accounting for Risk in P3-VALUE 2.0

<table>
<thead>
<tr>
<th>Risk Type</th>
<th>VfM PSC</th>
<th>VfM P3</th>
<th>PDBCA PSC</th>
<th>PDBCA P3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base variability</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Pure risk</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Lifecycle performance risk</td>
<td>✔️</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Revenue risk</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Risk Analysis Challenges

- Estimating risk impacts and probabilities
- Accounting for correlation among risks
- Accounting for unidentified risks
- Avoiding double-counting of risks
- Aggregating low probability/low consequence risks
- Accounting for procurement phase risks that are unique to P3s
- Bias of evaluators
Test Your Knowledge

True or False

- The WACC for a toll concession includes a risk premium that accounts for revenue risk as well as for lifecycle performance risks.
Questions?

Submit a question using the chat box
Part 5

Risk Allocation
## Risk Transfer by Delivery Type

<table>
<thead>
<tr>
<th>Procurement Type</th>
<th>Design Risk</th>
<th>Construction Risk</th>
<th>Financial Risk</th>
<th>O&amp;M Risk</th>
<th>T&amp;R Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-Build (DB)</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design-Build-Finance (DBF)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Design-Build-Finance-Operate-Maintain (DBFOM) with Availability Payment</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Design-Build-Finance-Operate-Maintain (DBFOM) with Toll Concession</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
## Typical DBFOM Risk Allocation

<table>
<thead>
<tr>
<th>Risk</th>
<th>Design-Bid-Build</th>
<th>Availability Payment DBFOM</th>
<th>Toll Concession DBFOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design errors</td>
<td>Public</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Change in scope</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Delay in permits</td>
<td>Public</td>
<td>Shared</td>
<td>Shared</td>
</tr>
<tr>
<td>Delay in right-of-way acquisition</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Construction cost overruns</td>
<td>Contractor</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Construction risks</td>
<td>Contractor</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Archeological findings</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Delay in relocation of cables &amp; pipes</td>
<td>Public</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Unknown ground conditions</td>
<td>Public</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Hazardous materials</td>
<td>Public</td>
<td>Shared</td>
<td>Shared</td>
</tr>
<tr>
<td>Security</td>
<td>Public</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Major maintenance cost overruns</td>
<td>Public</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Snow &amp; ice removal cost overruns</td>
<td>Public</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Regular maintenance</td>
<td>Public</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Traffic information systems</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Incident management</td>
<td>Public</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Toll revenue risk</td>
<td>Public</td>
<td>Public</td>
<td>Contractor</td>
</tr>
<tr>
<td>Financing risks</td>
<td>Public</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Force majeure</td>
<td>Public</td>
<td>Shared</td>
<td>Shared</td>
</tr>
</tbody>
</table>
Risk Allocation Steps

Step 1: Likelihood
• Which party is best able to control the likelihood of the risk occurring?

Step 2: Impact
• Which party is best able to control the impact of the risk?

Step 3: Lowest Cost
• Which party is best able to absorb the risk at lowest cost if the likelihood and impact cannot be controlled?
Transferred Risks

- Transferred risks include risks pushed down to subcontractors
- Efficient P3 risk management may reduce overall risk valuation and contingencies

![Diagram showing cost reductions in coordination, construction, and operations]
# Example Tunnel Project

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Risk Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Public</td>
</tr>
<tr>
<td>Political</td>
<td>✔</td>
</tr>
<tr>
<td>Financial</td>
<td></td>
</tr>
<tr>
<td>Traffic and Revenue</td>
<td>✔</td>
</tr>
<tr>
<td>Right of Way</td>
<td>✔</td>
</tr>
<tr>
<td>Planning and Permitting</td>
<td></td>
</tr>
<tr>
<td>Utilities</td>
<td></td>
</tr>
<tr>
<td>Procurement</td>
<td>✔</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>Operations and Maintenance</td>
<td></td>
</tr>
<tr>
<td>Hand-Back</td>
<td></td>
</tr>
<tr>
<td>Force Majeure</td>
<td></td>
</tr>
<tr>
<td>Change in Law</td>
<td>✔</td>
</tr>
<tr>
<td>Geotechnical</td>
<td></td>
</tr>
</tbody>
</table>
Test Your Knowledge

True or False

- The public agency’s goal in risk allocation should be to transfer all risks to the private partner in a P3.
Questions?

Submit a question using the chat box
Part 6

Using P3-VALUE 2.0 for Risk Assessment
FHWA’s P3-VALUE 2.0

Value for Money Analysis

- VfM
- Conventional Delivery
- P3

Inputs

- Costs
- Risks
- Revenues
- Financing & Tax
- Benefits

Project Delivery Benefit-Cost Analysis

- Conventional Delivery
- Delayed Conventional Delivery
- P3
- PDBCA

P3 Efficiencies

- Costs/Risks
- Benefits

Innovative Program Delivery
U.S. Department of Transportation
Federal Highway Administration
Training Modules

Value for Money Analysis

Risk Assessment

Project Delivery Benefit-Cost Analysis

Financial Viability Assessment
Training Navigator User Interface

Welcome to the P3-VALUE 2.0 Training Navigator! Please select one of the four training modules below.

If you would like to access the full P3-VALUE 2.0 model, click the “Go to Model Navigator” button on the right.

Training Module Selection

Module 1
Value-for-Money Analysis

Module 2
Project Delivery
Benefit-Cost Analysis

Module 3
Risk Assessment

Module 4
Financial Viability
Assessment

Inputs

- InpTiming&Cost: Project timing and cost inputs
- InpSeries: Construction, ramp-up and milestone payments time series inputs
- InpFin: Financial inputs
- InpRisk: Risk inputs

Outputs

- Risk Output for VfM: Risk outputs related to VfM
- Risk Output for PDBCA: Risk outputs related to PDBCA

Training Module selection
Input sheet selection
Output sheet selection
Demonstration of Risk Module

Please stand by as we open the Excel file
Questions?

Submit a question using the chat box
Webinar Recap

Part 1  Categorizing Risk
Part 2  Risk Management Process
Part 3  Pure Risk Assessment
Part 4  Lifecycle Performance and Revenue Uncertainty Risk Assessment
Part 5  Risk Allocation
Part 6  Using P3-VALUE 2.0 for Risk Assessment
Tool and References

- P3-VALUE 2.0 Excel Spreadsheet
- User Guide
- Risk Assessment Primer & Guidebooks
Upcoming P3-VALUE Training

- Exercise review – March 14 at 12:30pm EST
- March 21 Financial Viability Assessment
- Exercise instructions may be downloaded from the web room
- Technical assistance options:
  - E-mail questions to: patrick.decorla-souza@dot.gov
  - Or call (202)-366-4076
  - Participate in “Exercise Review” webinar

To access the Exercise Review webinar, please use the following link and telephone number:

- **Link**: https://connectdot.connectsolutions.com/p3
- **Telephone**: 1-888-363-4749, **Passcode**: 6139168#
Resources

FHWA’s Office of Innovative Program Delivery Website:
http://www.fhwa.dot.gov/ipd/

P3 Website:
Questions?

Submit a question using the chat box
Contact Information

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