Capital Projects
Project Risk Management – Leading Practices

January 2016
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Introductions

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John is a Specialist Master in the Capital Projects Consulting practice in the Philadelphia office of Deloitte Advisory.

He is a registered professional engineer and certified cost professional with over 20 years of dispute resolution, project advisory, and risk experience spanning a wide range of domestic and international engineering and construction projects. He has significant experience in construction disputes, estimations, project management, risk assessments, project controls, procurement, construction cost assessments, on-site claims management, and construction field experience. Furthermore, he has been involved in the construction, as well as construction disputes, audits and risk assessments, of industrial and power plants for projects in Canada, Central Europe, the Caribbean, Brazil, the Middle East, and the United States. John has also been a subject matter expert and assisted internal audit teams in numerous construction cost assessments, fraud investigations, control, and risk assessments for a number of domestic and international clients.
Challenges of Large Capital Projects
Root Causes

Root causes of many breakdowns are within the owner’s control

• Inadequate risk planning and monitoring
• Lack of clear governance structure and accountability
• Poorly developed project team
• Insufficient resources
• Limited controls for avoiding cost and schedule overruns
• Inadequate project reporting
• Inadequate contract planning/undefined contracting strategies
• Inability to accurately estimate and measure productivity
• Late scope changes
• Insufficient change and issue management processes
• Poor communication

Owner Pays

• Cost overruns
• Schedule delays
• Unplanned scope changes
• Contract/claims
• Abandoned projects
• Under-utilized assets
• Quality issues
• Lack of stakeholder acceptance
• Bad publicity
Polling Question #1

During your experience in executing capital projects, what risk keeps you up at night?

1. Schedule delay
2. Cost overruns
3. Resources
4. Procurement
5. Other
The Construction Industry Institute Top 107 Project Risks

1. Acquisition of necessary easements
2. Adequacy of labor force
3. Ambiguous acceptance criteria
4. Archaeological discoveries
5. Availability of materials
6. Back charge provisions
7. Bonding capacity
8. Broad transfer of ownership of intellectual property to owner/contractor
9. Cumulative impact of change orders
10. Change management
11. Civic/community activism
12. Consequential damages
13. Constructability/operability/maintainability analysis
15. Contractor skills and experience (type and size)
16. Control of scope growth
17. Coordination with other on-site contractors
18. Cost compensation for change orders
19. Cost escalation
20. Currency fluctuations
21. Delegation/allocation of design responsibility
22. Delivery sequence of long lead items
23. Design responsibility
24. Differing site conditions
25. Dispute provisions
26. Drawings not coordinated
27. Economic feasibility analysis (cost/benefit)
28. Environmental liability
29. Errors and omissions
30. Estimating
31. Express warranties
32. Financial capacity of contractor
33. Financial capacity of owner (funding of the project)
34. Financial capacity of subcontractor
35. Force majeure
36. Geo-technical data
37. Hazardous materials plan
38. Identification of underground site features (utilities, old building foundations, etc.)
39. Implied warranties
40. Incentives/disincentives clauses (safety incentives, rewards in general)
41. Indemnity (including gross negligence, sole negligence, and willful misconduct)
42. Inflation
43. Insufficient contractor insurance
44. Insufficient owner insurance
45. Insurance allocation
46. Integrated schedule management
47. Interest rate changes
48. Labor strike/jurisdictional disputes
49. Lack of appropriate involvement of design professional during construction
50. Lack of clearly defined safety guidelines and responsibilities
51. Lack of coordination/communication program among owner and design/construction teams
52. Lapsed insurance coverage
53. Latent defects
54. Legislative changes
55. Level of public support
56. Limits of liability
57. Liquidated damages
58. Local codes and standards
59. Local taxes
60. Most-favored-customer pricing provisions
61. New or unfamiliar technology
62. No damages for delay
63. Notice requirements
64. Overlapping insurance coverage
65. Owner-furnished equipment delivery
66. Owner-furnished equipment performance
67. Owner inspection requirements
68. Owner-mandated subcontractors/vendors
69. Owner operations and maintenance
70. Owner organizational structure
71. Owner skills and experience
72. Payment provisions (percent complete, milestones, deliverables)
73. Pay when paid clause
74. Permitting obligation
75. Pollution liability
76. Poor subcontractor performance
77. Post-award changes or reinterpretation of laws
78. Quality of workmanship
79. Regulatory permitting and mitigations
80. Reliance of subcontractors versus self-performing
81. RFI process
82. Risk of physical loss or damage to the work as pertains to builder’s risk
83. Schedule acceleration
84. Scope definition
85. Shop drawing approval process
86. Site layout
87. Site security
88. Site selection
89. Standard of care (engineering and construction)
90. Subcontractor default
91. Subcontractor safety training
92. Sufficient transportation facilities
93. Supplier performance
94. Tax regulation change
95. Termination rights
96. Third-party performance/errors litigation risk (subcontractor/supplier performance)
97. Time compensation for change orders
98. Trade coordination
99. Uncertain labor productivity
100. Unknown conditions
101. Unrealistic performance schedules
102. Unsafe construction site
103. Using standard trade practices as solutions for design shortcomings
104. Waiver of claims
105. Waiver of liens
106. Waiver of subrogation
107. Warranty work
Building a Risk Intelligent Enterprise
Best Practices
ERM vs. Project Risk

Makes risks more visible to management, stakeholders, and the Board of Directors so that management decisions can be evaluated and challenged.

<table>
<thead>
<tr>
<th></th>
<th>Red</th>
<th>Yellow</th>
<th>Green</th>
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</thead>
<tbody>
<tr>
<td>Corporate</td>
<td>$100+ M</td>
<td>$50-100M</td>
<td>&lt;$50M</td>
</tr>
<tr>
<td>Segment</td>
<td>$30+ M</td>
<td>$10-30M</td>
<td>&lt;$10M</td>
</tr>
<tr>
<td>Function</td>
<td>$10+ M</td>
<td>$3-10M</td>
<td>&lt;$3M</td>
</tr>
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</table>

Projects mitigate company risks and are therefore, also included in the ERM tool.

- **Monthly reporting:** An overall project risk indicator (red, yellow, or green) shall be reported monthly. The risk indicators will be determined based on the severity of the risks measured in terms of the potential impact (in a dollar equivalent) from the project risk register.
The Risk Management process is directed toward achieving the following goals:

- Streamline and standardize the identification, analysis and mitigation of significant risks to program success
- Identify risks with the greatest potential to impact project cost, schedule and performance criteria
- Allocate resources efficiently and in a cost-effective manner to mitigate the highest priority risks early in the planning process
- Promote risk management as an ongoing project control imperative that focuses on defining the project risk profile as it evolves throughout performance

Monte Carlo Analyses

Risk Evaluation Forms

Risk Identification: Implement a standardized methodology for identifying, prioritizing and managing project risks
- Procedures and Guidelines
- Roles and Responsibilities
- Risk Tolerances
- Process and Tools

Risk Assessment: Approach to Risk Assessment
- Qualitative
- Quantitative

Risk Register

Risk Matrix

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Path Forward…

Avoidance

Transference

Mitigation

Acceptance

- Risk re-assessment
- Risk audits
- Variance and trend analysis
- Earned value analysis
- Status meetings
Bridging the Gap

Clearly defined governance structure with accountability for all necessary risk classes assigned accordingly

Deloitte POV on Project Risk

Major capital projects tend to have extremely complex stakeholder structures with multiple relationships that come into play. Risk intelligent project officers ensure governance is enabled through three lines of defense:

• First line: Accountability for risk is secured through a clearly articulated risk breakdown structure that outlines all necessary risk classes, individual roles and specific responsibilities;

• Second line: Risk oversight and tone setting is provided by a central governing body which receives timely and accurate risk information upon which to make informed decisions;

• Third line: Independent and objective reviews are conducted to validate risk data and controls.

Governance structure must be aligned with the contracting strategy and organizational structure.

Portfolio and ERM Integration

Governing bodies (board, steering committee, audit committee, ERM, etc.) all have appropriate transparency and insight into the project’s risk management practices.

• Ensure that appropriate, consistent systems and processes are in place to manage risk proactively as well as provide timely risk information that may be escalated as necessary;

• Examine the current risk structure across the portfolio. How are risks being managed? Are risk silos being bridged?

• Ensure risks remain visible to those beyond the risk owners — the broader stakeholder group needs to be engaged.

Out of sight means out of mind
### Stage Gate Approach

#### Project Critical Decision Process Matrix

<table>
<thead>
<tr>
<th>PHASE</th>
<th>INITIATE</th>
<th>DEVELOP</th>
<th>DEFINE</th>
<th>PREPARE</th>
<th>EXECUTE</th>
<th>TURNOVER</th>
<th>CLOSEOUT</th>
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<tbody>
<tr>
<td><strong>Level of Development</strong></td>
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<tr>
<td>Governance/CD Approver</td>
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<tr>
<td>Major Capital Projects</td>
<td>Board of Directors</td>
<td>Sustaining Capital</td>
<td>Owners Committee</td>
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<tr>
<td>Critical Decision Approval Committee</td>
<td></td>
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<tr>
<td>CD-0 Template</td>
<td>Synchronization Matric/Decision Support Template</td>
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<tr>
<td>CD-1 Template</td>
<td>PMP (Initial)</td>
<td>Project Charter (Initial)</td>
<td></td>
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<tr>
<td>CD-2 Template</td>
<td>PMP (Updated)</td>
<td>by Discipline</td>
<td>Performance Baseline</td>
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<td></td>
</tr>
<tr>
<td>CD-3 Template</td>
<td>PMP (Final)</td>
<td>Commissioning Plan (Initial)</td>
<td>Performance Baseline</td>
<td></td>
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</tbody>
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#### Critical Decision Criteria

- **CD1**: Approve Business Case Feasibility Statement
- **CD2**: Approve Submission of Proposal
- **CD3**: Approve Performance Baseline
- **CD4**: Approve Execution Readiness
- **CD5**: Approve Acceptance and Turnover Activities
- **CD6**: Approve Final Project Closeout

#### Key Deliberables

<table>
<thead>
<tr>
<th>Phase</th>
<th>Deliberable</th>
</tr>
</thead>
</table>
| Prep | Sustainability |}

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### Legend

- **Project Management Deliverables**
- **Engineering Deliverables**
- **Reviews**

### Critical Decision Deliberables

- Executive Board
- Approval by Discipline
- Final Operational Acceptance
- Final Project Documentation
- Lessons Learned

### Specific Phases

- **Initiate**: Assess Business Case Feasibility
- **Develop**: Define Work Packages
- **Define**: Prepare for Construction
- **Prepare**: Define Design and Prepare for Execution
- **Execute**: Critical Decision Approval
- **Transition/Closeout**: Final Operational Acceptance
In a risk intelligent project, stage gate specific project assurances activities are required in order to determine whether the project may proceed.

**Deloitte POV**

Top project management teams develop an early view of what risk based activities are required per phase and stage gate in order to provide assurance that the project is ready to proceed through each gate. The project assurance plan is used to formulate a risk-based operational excellence program for the entire end-to-end project lifecycle. Ineffective stage gate risk assurance and related decision making often results in carry over legacy issues which burden the project for the remainder of its lifecycle.

**Stage-gate project assurance activities**

- Discipline specific risk studies (e.g. engineering, procurement, construction, etc.)
- Class specific risk studies (e.g. regulatory, security, political, resources, etc.)
- Resource, cost and schedule peer reviews
- Contingency analysis
- Vendor qualification analyses
- Internal control audits
- Independent project assurance
- Operational readiness reviews
In a risk intelligent project, material-risk classes, as well as all associated controls, are independently tested and validated

### Deloitte POV

In many major capital projects, internal resources are stretched and struggle to consistently deliver the necessary performance and control assessments. Project officers may fear they are not getting the full story from their project teams and that bad news may not arrive in time to address the risks. Without independent project assurance, project officers will find themselves in a position where they are relying on those who manage the risks to report on the risks.

### Stage-gate project assurance activities

- Timely access to specialized expertise
- Greater integrity and higher quality
- Neutral and un-biased opinions
- Additional resourcing options
- Broader exposure to industry best practices
Appendix
Quantitative (Monte Carlo) Risk Analysis

Quantitative risk analysis enables the client to identify and mitigate “high impact” risks inherent in traditional cost estimates and schedule projections

- Traditional cost estimating and CPM scheduling does not account for risk or uncertainty
- Monte Carlo simulation and scenario analysis accounts for both risk and uncertainty related to cost estimates and project schedules
  - Cost and schedule confidence: Monte Carlo simulation and scenario analysis will help to evaluate the range of expected costs or schedule completion dates as well as the confidence levels associated with achieving certain cost or schedule objectives
Risk Assessment Process

Simulation (Monte Carlo) Process

• Establish the model structure
• Define the inputs
  – Conduct risk workshops and assess relevant support
• Run the simulation
  – During each iteration, the model selects cost or durations for each item and risk event based on the probability distributions established
  – The simulation model may be run thousands of times while various statistics are collected
  – Results will converge to a level of confidence
    • Additional simulations will not have a significant impact on the results already collected
• Key outputs include:
  – Histograms showing the anticipated costs or schedule completion dates and their associated confidence levels
  – Statistics showing key drivers of risk and uncertainty
• Perform scenario analyses as necessary
Risk Uncertainty vs. Risk Events

• Risk uncertainty
  – Inherent uncertainty

• Risk events
  – Event may or may not occur (unknown site conditions)
  – External to cost items and schedule tasks
  – May impact several cost items or the duration of one or more tasks within a schedule
  – Modeled using two inputs: Probability of Existence and Impact
Defining Risk Inputs

Choosing the appropriate curves

• Typical distributions for construction activities
  – Right-skewed distributions: greater tendency (probability) of extending durations
• Utilize historical data to develop risk inputs
  – Each project has unique circumstances and challenges
  – May need to modify or adjust historical data
• Leverage industry knowledge
  – Educated assumptions
Triangle Distribution

The Triangular Distribution

Probability Density, $P(x)$

Inputs: minimum, most likely, maximum
Quantitative cost estimate analysis provides the means to quantify and evaluate cost estimate confidence.
Evaluated component costs likely to have the greatest impact on overall project cost and develop mitigation strategies to proactively address risks

• The tornado chart depicts the impact of high risk cost items in relation to the overall cost

<table>
<thead>
<tr>
<th>Component</th>
<th>Impact Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1410 - Regulatory Impacts</td>
<td>53%</td>
</tr>
<tr>
<td>1400 - Engineering</td>
<td>53%</td>
</tr>
<tr>
<td>1450 - Piping Scope Uncertainty</td>
<td>35%</td>
</tr>
<tr>
<td>1480 - Rock removal</td>
<td>32%</td>
</tr>
<tr>
<td>1540 - Testing &amp; Commissioning</td>
<td>26%</td>
</tr>
<tr>
<td>1460 - Building Design Uncertainty</td>
<td>26%</td>
</tr>
<tr>
<td>1470 - Access Road Improvements</td>
<td>20%</td>
</tr>
<tr>
<td>1860 - Electrical Scope Uncertainty</td>
<td>13%</td>
</tr>
<tr>
<td>1850 - Labor Availability</td>
<td>9%</td>
</tr>
<tr>
<td>1830 - Generator Procurement</td>
<td>4%</td>
</tr>
</tbody>
</table>
Quantitative Risk Analysis – Schedule Confidence

Quantitative schedule analysis provides the means to quantify schedule confidence.
Quantitative Risk Analysis – Schedule Criticality

Evaluate probable critical path, assess controlling tasks, and identify any potential logic flaws

- The criticality chart depicts the percentage of time each task appears on the critical path during the simulation analysis

Schedule Criticality Tornado Chart
## Identified Risk Elements

<table>
<thead>
<tr>
<th>Planning &amp; Design</th>
<th>Procurement</th>
<th>Construction</th>
<th>Project Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Drivers</td>
<td>Procurement Procedures</td>
<td>Physical Site Constraints</td>
<td>Schedule Controls</td>
</tr>
<tr>
<td>Permits</td>
<td>Engineering</td>
<td>Labor Productivity</td>
<td>Cost Controls</td>
</tr>
<tr>
<td>Regulatory Approvals</td>
<td>Inventory Control</td>
<td>Site Coordination</td>
<td>Invoice Processing</td>
</tr>
<tr>
<td>ROW/Land Acquisition</td>
<td>Long-Lead Items</td>
<td>Site Staffing</td>
<td>Material &amp; Equipment</td>
</tr>
<tr>
<td>Labor Availability</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Governance Structure</td>
<td></td>
<td></td>
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<tr>
<td>Public Relations</td>
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# Planning Phase Risks & Mitigation Strategies

<table>
<thead>
<tr>
<th>Risk Issue</th>
<th>Proposed Mitigation Strategies</th>
<th>Existing Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Drivers</strong></td>
<td>- Engage scheduling engineer to test baseline schedule, monitor weekly updates, and conduct trend and forecast analyses &lt;br&gt; - Drive management decisions based on progress</td>
<td>- Contractor maintains master project schedule &lt;br&gt; - Owner to monitor Contractor performance against schedule &lt;br&gt; - Owner seeking approval for project controls positions</td>
</tr>
<tr>
<td><strong>Permits</strong></td>
<td>- Comprehensive master permit list &lt;br&gt; - Division of Responsibility &lt;br&gt; - Monitor on master schedule</td>
<td>- Contractor has permit risk &lt;br&gt; - Schedule reflects permit requirements &lt;br&gt; - Weekly progress meetings with permitting and engineering teams</td>
</tr>
<tr>
<td><strong>Regulatory Approvals</strong></td>
<td>- Drive approval process through public relations and communications efforts</td>
<td>- Communications plan in place &lt;br&gt; - Public relations firm retained &lt;br&gt; - External Affairs retains local consultants</td>
</tr>
<tr>
<td><strong>ROW/Land Acquisition</strong></td>
<td>- Integrate with procurement and construction &lt;br&gt; - Secure material staging areas early &lt;br&gt; - Develop system for commitment &amp; transfer of funds</td>
<td>- Acquisition plans are in process and will be part of Execution Plan &lt;br&gt; - Condemnation may be used when CPCN issued &lt;br&gt; - Funding process and controls under development</td>
</tr>
</tbody>
</table>
## Planning Phase Risks and Mitigation Strategies

<table>
<thead>
<tr>
<th>Risk Issue</th>
<th>Proposed Mitigation Strategies</th>
<th>Existing Controls</th>
</tr>
</thead>
</table>
| **Labor Availability** | • Quantity and quality of craft labor  
• Overtime and productivity  
• Management and engineering resources | • Labor plan to identify alternate sources of craft labor  
• Incentives for retaining supervisory and engineering staff | • Contractor to conduct craft labor survey and develop project labor plan  
• Engineering divided among several firms  
• Contractor has commitment of contractor with sufficient resources  
• Owner compensation package designed to retain staff |
| **Governance Structure** | Designed to drive sound management decisions and support prudence reviews | Routine assessment of Owner and Contractor compliance with systems and processes | Three control points include Contractor as CM, project oversight team (including project controls), and Steering Committees (contractual and internal). |
| **Public Relations** | Effect of public opinion on regulatory approvals, ROW/land acquisition and route selection, and construction schedule | Monitor organized activity  
Develop focused media and PR campaigns  
Conduct training | • PR firm has been engaged  
• Communications plan in place  
• Various training has been completed |
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